Translating the Intimate:

Digital Renderings of Bio-matter into Material Forms through Artistic Research

Volume 1 of 2

Exegesis

Katy Louise Connor

A thesis submitted in partial fulfillment of the
requirements of Bournemouth University
for the degree of Doctor of Philosophy

Faculty of Media and Communication, October 2016

Abstract

"Art invites us and allows us to linger at the frontier of what there is,
and it gives us an outlook on what might be." (Borgdorff, 2010, p. 61)

Developing a body of work that explores an intimate relationship between my blood and the machinic in a practice-led process of fabrication, this PhD enquiry considers how the materiality of my body is translated, dispersed amongst the non-representational "froth of code"; becoming techno-corporeal abstractions through techno-scientific processes. This is my distinct contribution to knowledge.

Throughout the written exegesis, *poetic praxis* is developed as my unique method of approach—both initiated and grounded by the nature of practice-led artistic research (praxis)—and philosophically inflected by *poesis:* processes of questioning and reflection that reanimate key aspects of current techno-scientific practice.

I reflect upon a series of works fabricated through both two and three-dimensional print practices: articulations which I read (after Chadwick) as my "Enfleshings"; a virtual fleshy materiality. I also provide a critical analysis of emergent material practices of 3D Print (also known as Additive Layer Manufacture). The exegesis elucidates the artworks, their materiality (as Nylon 12) and concludes by considering future scenarios of biological techno-scientific practice, in which the body itself becomes 'fabricated'.

A portfolio of practice is presented as a parallel volume, which enables the reader to navigate documentation of the artistic research process. These stem from early studio-based experiments; tacit-intuitive approaches to materials and processes which foreground later, lab-based fabricated works. The portfolio includes photographs of the completed series of art works, collectively named as *Untitled_Force* (2011-2015) alongside documentation of their public exhibitions, reconfigured as sculptural installation at three different sites.

I argue throughout that *poetic praxis* as a methodology is a vital means of approach, revealing the unknown within existing instrumental research paradigms.

Acknowledgments

Firstly I would like to acknowledge the financial support provided by the Arts and Humanities Research Council which enabled me to undertake the PhD Research Project and in addition to this, the Bournemouth University Graduate School Santander Bursary, which funded the experimental 3D Print work.

I would like to express my sincere gratitude to my Supervisors, Professor Neal White and Dr. Tom Davis for their consistent and valuable support throughout; Susan Sloan and Dr. Stephen Bell for their insightful comments during the Transfer; and the members of EMERGE (Experimental Media Research Group) at Bournemouth University. Thank you also to Jan Lewis (and her family) for their kind hospitality during my frequent stays in Bournemouth.

I would like to thank Professor Mike Philips (iDAT) for his guidance as third Supervisor and Professor Genhua Pan, also at Plymouth University for the facilitated use of the Atomic Force Microscope.

I would like to extend my deepest thanks to my Examiners, Professor David Garcia and Dr. Tracey Warr, for their time, insightful questions and inspiring comments.

I would also like to express my gratitude to:

James Bradbury, Coordinator and Research Fellow at the Centre for Additive Layer Manufacture (CALM) Exeter University, for his enthusiasm for the project and willingness to experiment;

Dr. Kristen Kreider, Director of the Practice-based PhD programme at Royal Holloway University for her time and interest in the project, and for making it possible for me to join seminars on methodologies of artistic research;

Matt Burrows, Curator at Exeter Phoenix Gallery, for initiating the links with CALM and enabling me to exhibit the work;

The community of artists at Spike Island Bristol, particularly Sophie Warren, Jo Lathwood, Solveig Settemsdal, Éilis Kirby, Colin Higginson and Richard Broomhall for their insightful contributions to the peer crit; and to artists Karen di Franco, Maia Conran, Melanie Jackson and Michael Stumpf for their engaging conversations during studio visits. Thank you to Dr. Mark Leahy for the gallery text, and to Samuel Rodgers for his astute proof-reading;

Finally - a special thank you to Stephen Cornford for his invaluable help and support throughout, and to our little son Luka, who arrived during the research project.

Contents Page

PART THREE

Appendices

Index of Figures

All images by the artist/author, unless otherwise stated

Figure 56: *Fragment 6* completed 3D Print (Photo: CALM 2014) (Appendix 9)

Figure 57: completed 3D Print works in studio (2015)

Figure 58: completed 3D Print works in studio (2015)

Figure 59: "*Imagine an Object and It Will Appear*"
New Scientist, Front Cover. (September 2000)

Figure 60: *Bioforme* light shade (2014)

Figure 61:. Nick Ervinck *AGRIEBORZ* (2009-2010) 3D Print 53x34 x33cm "the image of a *perfectly symmetrical* cyborg figure. ... Working in a close parallel to science, Ervinck is able to develop new realities that can in turn inspire scientists." (Ervinck 2016) (my emphasis)

Figure 62: Bitonti (2014) Video still from 'Designer Francis Bitonti talks about his 3D-printed dress for Dita von Teese'.

Figure 63: *The object becomes tactile:* holding *Fragment 1, Untitled_Force.* Self-portrait, studio (2015)

Figure 64: *The object becomes tactile:* holding *Fragment 1, Untitled_Force.* Self-portrait, studio (2015)

Figure 65: original slide (2011)

Figure 66: original slide, alternate view (2011)

Figure 67: *Untitled_Force Fragment No. 4* (detail) (2015)

Figure 68: *Untitled_Force Fragment No. 1* (detail) (2013)

Figure 69: Katy Connor *Aureole* (2007)
Multi-channel Installation at VIVID, Birmingham's Centre for Media Arts

Figure 70: Katy Connor *Pure Flow* (2009) GPS Noise as Poetic abstraction. A/V Installation at Exeter Phoenix (4 channel audio with suspended screen) Photograph: Bill Leslie

Figure 71: Installation view, Exeter Phoenix (November 2015)

Figure 72: Installation (detail) Cuboid forms of monitor and casing (2015)

Figure 73: *Zero Landscape* detail (2016) Test Space Spike Island, Bristol

Figure 74: *Zero Landscape* (2016) The Control Room, Bristol

Figure 75: *Zero Landscape* (detail) (2016) The Control Room, Bristol

Figure 76: The Control Room, Harbourside, Bristol with full Moon (2016)

Figure 77: Bakelite Plastics Advertisement (1943) *The Crown Colonist.* October (p. 54) From presentation by Jo Stockham, *ReDefining Print* Exeter (November 2015). Photo: iPhone 5 Smartphone

Figure 78: "*News about Nylon: it all started with a stocking*". Advertisement for Nylon Stockings, Du Pont (Sickels 2004 p. 93)

Figure 79: La Roche, F. (Date unknown) "Pioneer 19th Alaskan explorers T. J. Richardson and Frank La Roche (standing) look down, from 1,800ft, on Muir Glacier." (*The Alaskan Experience*. p. 31)

Figure 80: Google Maps satellite view over Muir Glacier (2015) Screenshot

Figure 81: *3D Printed Foetus* (2015) from 3D Print.com (January 2015)

Figure 82: Studio tests:
Fragment no. 4 with scale model figure (May 2015)

[BLANK PAGE]

the ‘body’ itself as, by movement of its own
tissues, giving the data of, depth.

Charles Olson (1965)
Proprioception

Introduction

This PhD research project is concerned with a series of works, collectively named as *Untitled_Force* (2011-2015). The work takes a sample of my blood as a starting point, and translates this biomaterial through a series of digital technical processes, namely those of Atomic Force Microscopy (AFM) and Additive Layer Manufacture (ALM). These are contemporary processes of measuring, modelling and image-making used currently in medical, scientific and industrial fields.

The reasons behind my decision to place my blood in the AFM machine were manifold, but primarily I wanted to create a metaphorical relationship with the machine, based on intimacy. I used these digital processes to translate the bio-matter through a non-optical scanning process into topographical data, printing these mediated forms as two-dimensional images and three-dimensional sculptures. Through doing so my intention was to make a space for data to meet the biological; locating this space as the ground or territory for the artistic research.

Research Questions

The exegesis together with the exposition of practice present a series of investigations that were initiated by the following questions:

- How does data 'meet' the biological or natural?
- At what points does the digital become material?
- What happens in this space: the surface tension between the digital and the material?
- How does the body re-encounter or re-engage with this material, this fabric?

Although these questions may appear at first glance rather nebulous or unclear, what I have found through this artistic research enquiry is that they articulate a threshold space that is incredibly generative. The ambiguity in fact reflects the complexity of this area of study; a space of multiplicity, both abstract and invisible yet fertile and palpable.

My aim for the research project was to consider and explore these questions through practice. My objectives were to produce a series of works that could embody and articulate this space in concrete form, through practice-based artistic research. The Portfolio volume therefore presents documentation of these works, as well as their public presentation in a number of different exhibition contexts. The written exegesis works alongside this volume to contextualise the practice as artistic research; to elucidate the thinking behind the works and processes involved in making, and to situate them in a social and cultural context.

The project is situated within a broad cultural field that asks how our transition into a digital age of information affects our material and perceptual experience of the world. Central to the research is the concern with technology as an influence on the ways that we see, think about and feel the world; in a fluid relationship between the material world and the imagination, in an increasingly mediatised culture.

In my artistic practice I consider the body as the locus for these shifts; therefore this PhD project is also located in the body's negotiations within a wider mediated sphere. As Caroline Jones, Curator and Professor of Art History at MIT, writes

> "The human sensorium has always been mediated […] but over the past few decades that condition has greatly intensified. Amplified, shielded, channeled, prosthetised, simulated, stimulated, irritated – our sensorium is more mediated today than ever before." (2006, p. 5)

It is important to note that this research project comes out of my participation in a number of residencies, just prior to starting the PhD. For twelve months (2010-11) I was Associate Artist at iDAT, University of Plymouth, where I had the opportunity to experiment with the scientific data visualisation process of Atomic Force Microscopy. Later that same year, in June 2011, I participated in a lab-based workshop at UCL exploring Synthetic Biology, facilitated by artists Oron Catts and

Daisy Ginsberg through the Arts Catalyst. Both of these residencies opened my awareness to forms of artistic research within the lab-based contexts of techno-scientific practice.

Immediately prior to starting the PhD I had also developed and released a smartphone app *PURE FLOW 2.0* (Brighton Digital Festival, September 2011); software which reveals the noise generated in locational data as a tangible presence in the environment. Over the course of the PhD research project, I presented *PURE FLOW 2.0* at the LUX Biennial of the Moving Image (ICA, 2012); at *Transmediale* (Berlin, 2013); and the work was shortlisted for the *Lumen Prize* (2013), which enabled it to be shown in wider international contexts, including New York Institute of Technology, Hong Kong, Athens and London.

Although I will not discuss this particular work as part of my exegesis, I do feel it is important to acknowledge it. This new body of PhD research comes out of some considerable reflection on *PURE FLOW 2.0*, especially as a consequence of presenting it in these different contexts. I have therefore included some information and documentation about *PURE FLOW 2.0* in the Appendices[1].

[1] (See Appendix 1: *PURE FLOW 2.0*).

Materiality

My reflection on the physical properties of technologies through the process of artistic research reflects a desire to engage with their materiality. As an artist practitioner I wish to offer alternative ways of looking, touching, and discussing technology: as medium, as material; the physically existent. As Laura U. Marks states in *Touch* (2002) this allows us to understand mediated spaces – the online or the televisual – not as virtual, transcendent and discreet, but as "material, immanent and interconnected" (p. 177).

My research practice comes from a willingness to engage with and a desire to learn from the slippery nature of technologies; their increasing miniaturisation to the point of invisibility and yet their pervasive presence. "To appreciate the materiality of our media pulls us away from a symbolic understanding and toward a shared physical existence" (Marks, 2002, p. xii).

This practice-based enquiry comes at a critical point in contemporary culture, when academics and artists alike are finally questioning the perceived 'immateriality' of digital material processes.[2] It is evidence of

[2] Ashley Scarlett, PhD Candidate at University of Toronto, Canada, names digital materiality as "an elusive phenomenon that is emerging as a critical area of inquiry for our time" (email, January 2014) [see Appendix 2].

In "Relive: Media Art Histories" (2013), editors Cubitt and Thomas have foregrounded the volume with a critical introduction, "The New Materialism in Media Art History", "as a counter to concepts of the immaterial, weight-less and friction-free" (p .2).

the timely nature of the research that discussions around materiality are beginning to surface, as to appreciate the materiality of our media pulls us into a shared materiality; a *shared* physical existence, starting with our body's fundamental need to make sense of the world around us.

> "Our current yearning for materiality, for thingness, for the concrete stuff of the physical world are here located in the body's desiring negotiations with the virtual and the mediated – ever more *intimately naturalised* as the sensory technological envelope in which we live." (Jones, 2006, p. 2, my emphasis)

Media technologies move at a pace; and in the current climate of the perpetual *Upgrade*, I'm aware that some of these readings and practices may already be out of date. For example, my photographs and 'screen-grabs' of early explorations and experiments made with Google Maps software at the start of the PhD also document a rapidly changing technology, as the visual language of this platform has shifted during the course of the research (2011-15). But this is not an engineering PhD; my aim is not to be ahead of the game, but rather to locate a body of research in a particular timeframe, within a rapidly changing arena. As Michael Biggs states, the difference between a practice-based PhD and an engineering PhD, even exploring the same objects and processes, is that artistic research will look at how the work sits in relation to other artworks and artists (Biggs, 2004, p. 3).

What I am doing, therefore, is contributing to a reading of our current cultural milieu, where the nature of the virtual, the digital and the physical cross and fuse on an intimate scale. My artistic research thus presents artefacts and objects that concretise experiential content; they give shape and form to experiential aspects of the research that quite simply cannot always be succinctly put into words.

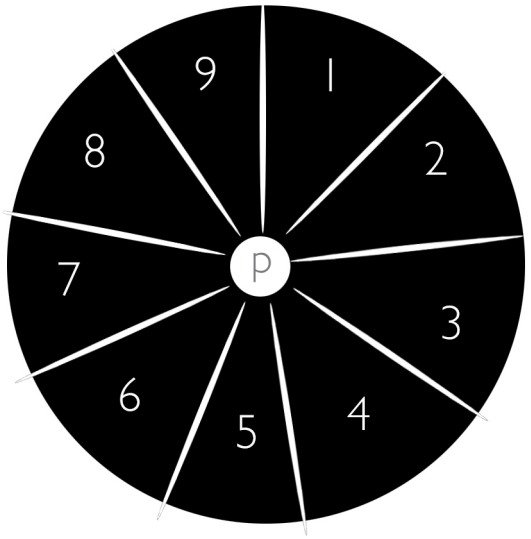
Methodology

Throughout the PhD, my artistic practice has been fundamental to the project, as the central driver of the research. The methodology that I have developed – *poetic praxis* – is artistic research, which comes directly out of artistic practice. This methodology is apposite for the subject area, for, as Jones writes, "Aesthetic practices locate how our bodies are interacting with technologies at the present moment, and provide a site for questioning these locations" (2006, p. 2).

My definition of artistic research draws from *The Production of Knowledge in Artistic Research* (2010) by Henk Borgdorff, who offers an illuminating yet succinct definition as follows:

> "Art practice qualifies as research if its purpose is to expand our knowledge and understanding by conducting an original investigation in and through art objects and creative processes. Art research begins by addressing questions that are pertinent in the research context and the art world. *Researchers employ experimental and hermeneutic methods that reveal and articulate the tacit knowledge that is situated and embodied in specific artworks and artistic processes.* Research processes and outcomes are documented and disseminated in an appropriate manner to the research community and the wider public." (p. 63 my emphasis)

My intention for this written exegesis together with the portfolio, is to reveal and articulate this tacit knowledge. I have organised the thesis



Schema 1: The Circular Structure of the PhD Thesis: how the Practice Portfolio (P) relates to Chapters 1-9 of the Exegesis (2016)

using a circular structure. Here, the writing circumnavigates the practice, situating it within a series of contexts and addressing its social and cultural relevance.

Conceptual Framework

The circular structure of the PhD thesis offers a means to address the artistic research by writing *around* the practice, placing the practice as the central pivot to the research project as a whole (see Schema 1). Organised through chapters 1-9, the written exegesis presents different viewpoints onto the practice (P). These chapters reflect on different aspects of the process and situate the work in different contexts; artistic and theoretical, philosophical and technological.

The making of the work therefore becomes central, not only to the writing of artistic research, but also to its *reading*. Following my methodology of *poetic praxis*, this circular structure for the exegesis also suggests something more akin to a poetic turn, rather than the logical linear argument set out and concluded in a traditional academic thesis. The practice, presented here in the portfolio of documentation (P) operates here as a central hub to the entire thesis.

Where the portfolio (P) documents the process, outcomes and public exhibitions, the writing contextualises and illuminates the art practice, so that the practice can be read through different contexts; seen through different lenses. Some of these are micro readings – close readings of a significant aspect of the work. Other sections take a step back,

positioning the work within a wider scopic field – as an overview of where the practice sits within the context of current technological production. Another may provide a haptic reading that touches carefully; brushes the surface and in doing so tries to get as close as possible to the subject. In this way, the writing loops around the art practice. It is not then a linear reading on the work, but works to reveal different aspects of the research practice, moment to moment. The exegesis thus serves as further documentation of the practice, situating it within certain perspectives and wider frames of reference.

My writing also shifts between the pragmatic, fundamental aspects of 'how the work was made', to more speculative discussions and metaphorical associations around the work's potential meanings and affects; how it might be experienced by an audience as a series of art objects in the gallery space. This is an important aspect of artistic research as, operating within both the academic context and the gallery, "it places itself on the border between academia and the art world." (Borgdorff, 2012, p. 117)

In a similar way there is a gap between what we know of how the work was made and how we experience it. Descriptions of how *Untitled_Force* was made do not necessarily say anything about how it might look, sound, or feel. Too much contextual information about the process of making the work, its materials, and methods, can obfuscate the affect; how the work is *encountered* by bodies in a gallery space – the "sensorial image" (Wanderley, 1993) – which is on a more visceral register. For this artistic research it is important to keep this dynamism open – in flux.

Whilst the written component of the research emphasises key elements and presents these as evidence, writing can only capture and make explicit certain aspects of the research process and findings. As Biggs states,

> "Explicit content is expressed linguistically. Tacit content has an experiential component that cannot be efficiently expressed linguistically. Ineffable content cannot be expressed linguistically." (2004, p. 7)

There is still a real need however, to communicate this experiential content at the heart of this artistic research. I have used a variety of methods to record and attempt to make this explicit; as it has arisen through and out of the practice (in the studio, on the screen, in the lab). In order to convey these tacit, ineffable and experiential aspects, then, my documentation includes photography and video, recording works in progress, workings out; and audio capture of discussions and conversations; processes taking place in the studio, in the lab, at my desk, and on the desktop.

> "Photographs and video-audio records may serve as documentary evidence in this context [...] [which] is in the first instance a process of making the tacit more explicit." (Nelson, 2006, p. 18)

Images as Associative Devices

Images are also placed within the exegesis as poetic devices; threading through the document as a parallel dynamic to evoke associative thinking. Through doing so, the research outcomes are placed in an open-ended context of artistic associations and techno-scientific references; situating the research in a broader ecological environment.

My decision to include images in this way, works as a deliberate device to not address themes directly or to explicitly *spell something out.* Rather, in allowing images their own autonomy, my intention is to introduce a further sense of poetics, allowing themes to work in ways that are more askance to the central focus; they are there but at the periphery of vision, at the edge of thought. These devices and tactics structured throughout the thesis are deliberate means of finding "ways of knowing the indistinct and the slippery without trying to grasp and hold them tight" (John Law, 2004, p. 3). Here, understanding becomes possible through techniques of deliberate imprecision, or evocation. As Henk Borgdorff states,

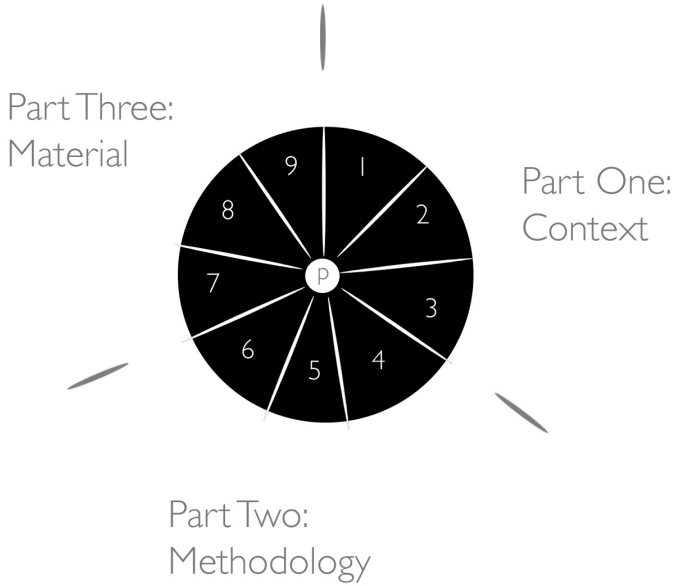
> "Artistic research is more directed at a not-knowing, or a not-yet-knowing. It creates room for that which is unthought, that which is unexpected – the idea that all things could be different. Especially pertinent to artistic research is the realisation that we do not yet know what we don't know. Art invites us and allows us to linger at the frontier of what there is, and it gives us an outlook on what might be." (2010, p. 61)

One of the strengths of artistic research is that it can bring into the academic arena forms of research practice that do not simply ape the traditional modes of argumentation. Artistic research adds value through its ability to make a series of statements around something without having to prove a point. Rather, concepts perceived intuitively (on the periphery) that disappear when looked at directly, can still be articulated and made apparent. John Law asks how we might catch some of these realities (2004, p. 2) to articulate or capture things that are unstable, or mean something in one circumstance but something quite different in another.

Examples of this visual chiming occurring in the thesis include the mimetic associations that occur between the 3D Printed art works and glacial icebergs; the sublime Arctic landscapes that I discovered in miniature inside the 3D Print machines in the lab (Figures 33 and 34). Here these themes rise and fall within the research, they surface at key points.

Similarly the writings of Donna Haraway and the lab-based artworks of Helen Chadwick that explore the techno-scientific investments into women's reproductive bodies, are contemporised in the 3D Printed foetus (Figure 81) an image that speaks volumes about a technological imperative to colonise such corporeal territories.

I have used the landscape format throughout the thesis presentation; situating the images alongside the text in the exegesis to convey both the explicit and the more associative or tacit content side by side. This 'placement' anchors the two modes of enquiry and gives them an equal value in the research.



Schema 2: The Circular Structure of the PhD Thesis: Parts One, Two and Three (2016)

My PhD thesis, *Translating the Intimate: Digital Renderings of Bio-matter into Material Forms through Artistic Research* is therefore set out as follows:

(P) Portfolio: Parallel volume

The Portfolio contains visual documentation of the artistic research: the research outcomes and public exhibitions alongside selected aspects of working processes. It is posited here as a parallel volume, so that it can be referred to alongside the written exegesis.

Part One: Context

This establishes the first stage of the research; the context; and addresses the first research question:

- How does data 'meet' the biological or natural?

The first Chapter introduces a philosophical approach to the enquiry: the key concept of poetics, which will be drawn on throughout the essay. Chapter Two, *Becoming Data,* explicitly addresses the first Research Question and first stage of the practice, working with an Atomic Force Microscope; placing the artistic research in a social and technological context. In Chapter Three I position my PhD research project within a current and recent historical artistic context, reflecting on the *Viral Landscapes* (1996) of Helen Chadwick, alongside *Null Object: Gustav Metzger thinks about nothing* (2012) by contemporary artists, London Fieldworks.

Part Two: Methodology

This section addresses my second and third Research Questions:

- At what points does the digital become material?
- What happens in this space: the surface tension between the digital and the material?

Here I present the artistic research methodology (Chapter Four), which includes both experimental studio practice and the lab-based fabrication process of 3D Print or Additive Layer Manufacture. Where Chapter Five gives an outline of the pragmatics in more detail, Chapter Six critically reflects upon 3D Print as contemporary practice, considering it in relation to Jean-François Lyotard's concept of the sublime.

Part Three: Material

This third section addresses the final Research Question:

- How does the body re-encounter or re-engage with this material, this fabric?

Where Chapter Seven focuses on the work as material metaphor, considering its meaning both in relation to the body and machinic intensities, Chapter Eight presents the research outcomes through sculptural installation, and an audience discussion on the work; as embodiments of the artistic research. Chapter 9 addresses some of the themes touched upon by the research, offering new perspectives and speculative insights. Through doing so, it places the artistic research back into a context of the cultural, technological and material practices of contemporary society.

My conclusion brings the research to a close, and presents concluding comments on the realisations gained through the process. In doing so, it points to future applications for the research within the contexts of academia and contemporary artistic practice.

[BLANK PAGE]

Part One

Chapter 1:
Philosophical Approach to the Enquiry

Introduction

In this chapter I will outline a broad philosophical approach to the enquiry, which will be developed throughout the exegesis. I will draw from figures including Martin Heidegger, Donna Haraway, Krzysztof Ziarek, and artist Susan Hiller, as well as Andrei Tarkovsky's *Solaris*, as an instance of science 'fiction'. This will articulate my approach to artistic research and my poetic relationship to technology in particular, which I name here as *poetic praxis*.

Solaris (1972) opens with Johann Sebastian Bach's chorale prelude for organ; a melancholic piece of music over credits and black leader. The opening shot reveals reeds suspended under the surface of a flowing stream, gently curling from the movement of the water, slightly undulating, with a backwards sensation as if the film were playing in reverse. The camera physically pulls in closer but the inner movement of the camera lens pushes the subject away, unsettling the relation between foreground and background in the frame. As a camera technique, this inner lens-shift is often used to denote a shift in meaning; it conveys a new realisation. In *Solaris*, this subtle dislocation enhances its uncanny quality.

Figure 1: *Solaris* Andrei Tarkovsky (MosFilm 1972)

Tarkovsky's camera pans left to uncover a still figure quietly observing the world around him; the reeds with their slow, uneasy quality, and the damp of the deep green leaves. The camera rises and we see the same figure walking his way through dense, misty undergrowth and around the edges of a large pool. A short time later, a shower of rain descends. The sound design activates another unusual jarring sensation; the sound of the raindrops falling into the pool is attended to rather like echoing drips in an enclosed space. This is a nature we're unsure about, burgeoning but eerily pregnant; full but with a sense of underlying unease.

In the novel *Solaris* (1961), Stanisław Lem creates a planet that gives material shape and form to an 'Otherness': a chilling manifestation of intelligence outside limited, human means of comprehension. *Solaris* communicates to humans by giving human form and physicality to their unconscious memories and desires, unsettling their prized scientific logic. Lem offers hypnotic descriptions of the temporal, multifarious forms created in the viscous membrane of the Solarian Ocean, to which the humans can only respond by detailed observation; their attempts to classify and categorise evidenced by book after book of mathematical data, a redundant taxonomy. His work as a writer is a meditation on the inability of Science to see outside of its own logic; the inevitable anthropomorphism of human perception. "The whole sphere of cognitive and epistemological considerations was extremely important in my book", he states (1987); "I wanted to create a vision of a human encounter with something that certainly exists […] but cannot be reduced to human concepts, ideas or images" (2002).

I'd like to draw an analogy here between *Solaris* and my approach to the PhD through artistic research, throughout the course of this enquiry. *Solaris* – both the film and the novel – is introduced here as a metaphor for the unease and shift between nature, science, memory and imagination. *Solaris* asks questions of what we know (about ourselves and the world around us) and what we don't yet (or can't ever) know. In doing so it articulates ways of coming to knowledge, and ways to approach and communicate this knowledge.

In *The Provisional Texture of Reality* (2008) Susan Hiller references *Solaris* as a gesture toward the uneasy relation between science and art. "Humans cannot make contact with the ocean that is *Solaris*, because they try to deal with it in instrumental ways rather than by intuitive or imaginative means" (p. 25).[1] *Solaris,* then, is also a story about an encounter with the unknown. In this project I consider this encounter in relation to the space *between* the digital and the material; my body's encounter with the *machine* and the surface that emerges out of that encounter.

This metaphor could equally be applied to a method of coming to know that is more to do with a questioning; "leading out onto that which science and the technological does not know how to encompass: *the art of the open*" (Quasha and Stein, 2000, p. 216). This sense of the poetic – this *art of the open* – is a dimension of the practice-based enquiry that has emerged through the research; it is an on-going discovery that the works presented here will elaborate further.

Artistic research stands in a particularly awkward historical relationship to 'knowledge' and academic institutions. Artistic research has a rich history of contributing to radical knowledge and epistemic disobedience: "the same stone can be described from the point of view of a discipline, which classifies and names; or read as evidence" (Steyerl, 2012, p. 56), witnessed as *manifestation.* There are many questions within the artistic community regarding the relevance and legitimacy of the PhD for artists.[2] As artists, the academic framework is but one of a series of networks and systems that can be seen to generate and give space to knowledge and practice.[3]

Artistic research has a different relation to knowledge production, where knowledge is related to perception. Seeing the world in new ways can bring about a change in understanding; interpretive knowledge places

[1] Hiller is speaking at the launch of *Syzygy*, a work by London Fieldworks (1997-1999). I will be discussing the work *Null Object* (London Fieldworks 2012) as part of the PhD research.

[2] See *Art Monthly* (2011-12) Letters between Price, Charlesworth and Suchin, in response to Suchin's article *Rebel Without a Course* (April 2011). Also blog entry by Dutton as a response to the furore: *Artists don't need PhD's but PhD's need artists. Perhaps* (2012).

[3] These other practices and networks include galleries, curators, artist-led organisations and archival practices, including museums. Recently there has also been a general shift in terms of academic institutions aligning with galleries (such as Bournemouth University / The Arts Catalyst and UWE / Arnolfini, Bristol).

value on providing new insight. As Barone and Eisner state, artistic research

> "addresses complex and often subtle interactions and that it provides an image of those interactions in ways that make them noticeable. In a sense, arts based research is a heuristic through which we deepen and make more complex our understanding of some aspect of the world." (2011, p. 3)

In this project I deepened and complicated my understanding of the relation between the digital, biological and natural, as material, process and fabric. My contribution to knowledge is presented here as a new figuration of this relation, and in the ways in which I imagine, interpret and understand this perceptual shift through *poetic praxis.*

Poetic Praxis

> "In what follows we shall be *questioning* concerning technology. Questioning builds a way. We shall be questioning concerning *technology*, and in so doing we should like to prepare a free relationship to it. The relationship will be free if it opens our human existence to the essence of technology." (Heidegger, 1977, p. 3)

As a means to conceptualise my poetic approach toward technology, I turn to Martin Heidegger's essay, *The Question Concerning Technology* (1977). [4] As one of the first figures to philosophically investigate technology, [5] Heidegger perceived it as both instrumentally and anthropologically derived. Technology, then, is not simply a collection of things and activities, but also "a *mode of truth* or a field within which things or activities may appear as they do" (Ihde, 2010, p. 32).

To summarise, Heidegger saw technology as implicated in a wider ideological system which challenges, demands and sets-upon nature, which he called *enframing,* This *enframing* of the world "threatens to sweep man away into ordering as the supposed single way of revealing, and so thrust man into the danger of the surrender of his free essence" (Heidegger, 1977, p. 32).

Heidegger claimed that modern technology, following on from *enframing*, "represents nature as a calculable coherence of forces" (p. 21), framing nature as a series of manipulatable objects and energy as "standing-reserve" (p. 17). Modern technology's role as an instrument, as a means, operates only in order to procure and extract this energy (p. 15): "Everything depends on our manipulating technology in the proper manner. […] We will master it." (p. 5). Technology (as technical *techné*) thus reinforces this *enframing;* its grip on the world, and man's place within it.

[4] Heidegger's essay, *The Question Concerning Technology* (1977) has recently been re-approached and re-contextualised by a number of authors, in the light of a shift in our understanding of technology and its ubiquitous presence in contemporary society; see (for example) Krzysztof Ziarek, *The Work of Art in the Age of Electronic Mutability* (2005), Curt Cloninger (2012) "Manifesto for a theory of the "New Aesthetic" (Mute) and "Imaginary Museums, Computationality & the New Aesthetic" from *Transmediale BWPWAP* (2013) Catalogue. Gansing, K. et al. (eds.).

[5] Heidegger is widely figured as one of the major figures in the foundations of the philosophy of technology, along with Marx (Ihde 2010).

However, Heidegger's aim with his essay was to counterpoise the instrumental conception of technology, or "*what* the thing is" (p. 4) (hereafter referred to as *techné* [6]), with its essence:

> "So long as we represent technology as an instrument, we remain held fast in the will to master it. We press on past the essence of technology." (p. 32)

Here, Heidegger distinguishes the essence of technology (*poiésis*) from the *instrument.* This essence of technology "belongs to bringing-forth, to *poiésis;* it is something poetic" (p. 13). Heidegger's essay thus presents an intriguing dynamic, locating the process of "bringing-forth" at the very heart of technology. Heidegger's careful choice of metaphors and their suggestion of emergence, opens the reader and practitioner to a relationship with technology that tends towards contemplation and meditation. Heidegger goes on to align *poiésis* with *physis;* nature as dynamic, connoting growth, development and metamorphosis.

> "It is of utmost importance that we think bringing-forth in its full scope […] not only artistic and poetical bringing into appearance and concrete imagery, is a bringing-forth, *poiésis. Physis* also, the arising of something from out of itself is a bringing-forth, *poiésis. Physis* is indeed *poiésis* in the highest sense. For what presences by means of *physis* has the bursting open belonging to bringing-forth, e.g., the bursting of a blossom into bloom, in itself." (p. 10)

A key phrase here is "the arising of something from out of itself". If we look at the translator's notes, William Lovitt states that it "can connote a change that is the negating of a former condition" (p. 10). This can also be associated with a *threshold* occasion.

Heidegger's questioning enables us to perceive an open simultaneity in conceptualising technology both as a medium and a material. Drawing from Heidegger, I propose that *poetic praxis* is also a method of eliciting this different relationship to technology. Praxis philosophies are those, that "make a theory of action *primary*. Theory of action precedes or *grounds* a theory of knowledge" (Ihde, 1979, p. xv). *Poetic praxis* is therefore a direction to action – to artistic research. When we apply this distinction between technology as tool (*techné)* and as bringing-forth *(poiésis)* to *making*, what emerge are questions around our approach to technology. How do we handle technology? Do we use it as a tool, as an instrument, as a means to an end? Or as something different? As a medium; through a contemplative process of unfolding, generation, and transmutation. "Everything, then, depends on this: that we ponder this arising and that, recollecting, we watch over it. How can this happen? Above all through our catching sight of what comes to presence in technology." (p. 32)

A significant aspect of *poetic praxis* as method comes from the alignment of *poiésis* with *physis* (nature; *natura* is the Latin translation from the Greek *physis)*. This (deeper) conception of the natural world – both the vast excess and intimate minutiae of the living, pulsating world around us and within us (metamorphosis, wildness, the sublime) – includes within it

[6] In this essay, for ease of definition, technical *techné* will be referred to as *techné* and poetic *techné* will be referred to as *poiésis*. Their difference lies "in the way in which they are technical" (Ziarek, 2005, p. 216).

a sense of mystery, and the possibility of the unknown. From this Heideggerian concept of *poiésis,* through *poetic praxis,* we can draw nature (the uncanny, the unknown) out from within the heart of the technical.

In *The Work of Art in the Age of Electronic Mutability* (2005) Krzysztof Ziarek translates Heidegger's approach for the digital age using a biological metaphor to allude to how invisible and embedded technological thinking has become. He states that "technology has come to operate at, or perhaps even *as,* the very nerve centre of art" (Ziarek, 2005, p. 214).[7]

In the digital age, the distinction between technology and art – *techné* and *poiésis* – is, he continues, "a critical difference in a preeminent sense" (p. 217). *Techné* (instrumental use) is predicated on manipulation, whereas *poiésis* presupposes neither function nor result. However, "what keeps art alive today is […] its capacity to stage this crisis […] to keep the scission between *poietic* and technical *techné* in play" (p. 217).

> "In the information age […] everything is determined in terms of its availability as information: what exists is seen as translatable into information and thus as intrinsically predisposed to being stored, manipulated, and processed as data." (p. 216)

[7] Many artists today are working with information and mediation, at the interface of art, science and technology. See Wilson, S. (2002) *Information Arts: Intersections of Art, Science and Technology.*

Through artistic research as *poetic praxis*, we can conceive of it as "a poetic, meditative thinking that inquires more profoundly […] displacing the technological Frame" (Quasha and Stein, 2000, p. 216). As Hiller articulates, rather than dealing with the technological in instrumental ways, we can consider it through intuitive or imaginative means (2008, p. 25).
As a strategy, then, *poetic praxis* can call attention to the poetics of technologies, revealing something *other* – a mystery and a depth to these machinic processes. It does this by questioning; seeking out the edges, finding their limits: "This is an art of the threshold, the liminal possibility, an art of beginnings" (Quasha and Stein, p. 216).

This art of the threshold, of liminal possibilities, is the ground for the research. To return to the research questions here: this space, "the surface tension between the digital and the material", is a liminal space – a threshold between the biological, natural and technological. *Poetic praxis* as approach – as method – generates a space in which to consider and reflect upon how technologies and bodies could meet: in a threshold occasion.

Donna Haraway's *Cyborg Manifesto: Science, technology and socialist-feminism in the late twentieth century* (1991) deepens and develops my understanding of these simultaneous aspects of technological apparatus – the differential between *techné* and *poiésis* in the contemporary age. Haraway writes that "technologies and scientific discourses can be partially understood as formalisations, i.e., as frozen moments, of the fluid social interactions constituting them"; "they should also be viewed as

instruments [devices or tools] enforcing *meanings*. The boundary is permeable between *tool and myth, instrument and concept*" (p. 164, my emphasis).

There is room here for *poetic praxis* to undo: to disassemble tool from meaning, instrument from its intended use or concept, and to insert instead a new poetic relationship of praxis. Following Heidegger, there is a possibility here for fluidity; for things to arise through a threshold occasion. "This is a struggle over life and death, but the boundary between science fiction and social reality is an optical illusion" (Haraway, p. 149).

Both Heidegger and Haraway inquire into the minutiae of techno-scientific processes: Heidegger through a questioning, through meditation, through thought; and Haraway through her figuring of the cyborg – intimacy interlaced with biotechnologies. For Haraway, however, the crucial dynamic is one of seeing things in fluid ways: both in the grip of control – the world as gridded system – and also our wired social and bodily relations (p. 154). At the same time, she warns, this can easily become a border space between such areas, and as such it is a policed, patrolled and politicised space, especially around areas of (women's) material bodies:

> "in the traditions of 'Western' science and politics […] the relation between organism and machine has been a border war. The stakes in the border war have been the territories of production, reproduction and imagination." (p. 150)

Haraway argues instead "for *pleasure* in the confusion of boundaries and for *responsibility* in their construction" (p. 150).[8] Drawing upon Haraway and Heidegger in thinking through the current contemporary technological climate, leads to a perception of technologies as elements enmeshed within wider systems of practice. These technologies enact particular ways of framing the world (Heidegger's "*enframing*"), and exercise power through (potentially) manipulative processes (Haraway's "enforcing"). Both offer critiques of techno-scientific *worlding*[9], and yet possibilities for an undoing, through artistic practice:

> "Because the essence of technology is nothing technological, essential reflection upon technology and decisive confrontation with it must happen in a realm that is, on the one hand, akin to the essence of technology and, on the other, fundamentally different from it. Such a realm is art." (Heidegger, 1977, p. 35)

But where Heidegger looks back to an earlier age for a sense of poetry, Haraway looks to a nature "revivified in the worlds charged with microelectronics and biotechnological politics" (1991, p. 162). Through her figuration of the cyborg, Haraway galvanises an active political stance:

> "inhabiting the cyborg is what this Manifesto is about […] The cyborg is a figuration but it is also an obligatory *worlding* – that inhabiting it you can't not get it – that it's a military project, a

[8] I shall return to these themes of techno-embodiment later in the essay, Chapter 9.

[9] The definition of *worlding* is that of "being-in-the-world" (Heidegger 1927): "a verb signifying something ongoing and generative, which could not be reduced to either a philosophical state or a scientific materiality." (worlding.org 2016)

> late-capitalist project […] and much more than that – cyborgs open radical possibilities at the same time." (p. 139)[10]

This realm where new systems of meaning can be developed is the area of my artistic research: *poetic praxis.*

Whilst initially outlined here in Chapter 1, *poetic praxis* is a strand that runs throughout this exegesis. As an approach it will be further developed through referencing the work of other artists, including Helen Chadwick and London Fieldworks, in Chapter 3. In Chapter 4 I develop *poetic praxis* as methodology, firstly through a figuration of crystallisation, and secondly in discussing the process of fabrication – where the poetic meets the techno-scientific practice of 3D Print: *3D Print as poetic praxis.*

[10] Haraway fully supported the work of artist Beatriz da Costa (1974-2012). She also recently worked with artist Tue Greenfort on *The Worldly House* (2012) and was member of the Honorary Advisory Committee at dOCUMENTA (13).

"The origin of the work of art is the artist's body – in the pressing and smearing, in the dailiness of bodily functions, in the question 'what kinds of marks can I *make*?'"

Helen Molesworth *Before Bed*
(1993, p. 79, my emphasis)

"It is no longer clear who *makes* and who is *made* in the relation between human and machine"

Donna Haraway *A Cyborg Manifesto*
(1991, p. 177, my emphasis)

Chapter 2:
Becoming data: *Untitled_Force*

Introduction

In this chapter I shall present the context for the artistic research and the first part of the practice, which involved working with the Atomic Force Microscope. During the PhD project I developed a series of works collectively named as *Untitled_Force*. The works explore and elaborate a data file of my blood, which was created with an Atomic Force Microscope (AFM). At 50 x 50 µm (micrometres) square or 50 x 10^{-3} mm (absolute size) the dimensions of the scanned sample were smaller than a single pixel on the touchscreen display of an Apple iPhone 4: the size of the blood scan is pixel scale.[1] The work simultaneously raises a number of key issues, which I will address over the next few pages.

In this chapter, therefore, I will be considering my initial research question; by asking this question, I will describe how the series of works *Untitled_Force* were initiated.

- How does data 'meet' the biological or natural?

To clarify, here I distinguish between the natural and the biological. My understanding of the natural is that it is the physical world around and within us, which we inhabit and that we are part of, also including the possibilities of the unknown (that which escapes the limits of human

[1] A single pixel on the Apple iPhone 4 touchscreen measures 78µm (B. Jones, 2015) and *Wikipedia: 10 micrometres* (2012).

understanding). The biological is the framing of this world (of living organisms) by science. To quote from Haraway (2006), biology is a "cultural-material practice" (p. 138). I will now briefly describe how we live in a mediated sphere of invisible data, ever more intimately naturalised as sensorial substance.

> "Modern machines are quintessentially microelectronic devices: they are everywhere and they are invisible."
>
> (Haraway, 1991, p. 153)

Technologies of the 21st Century are everywhere; being "quintessentially microelectronic devices" (Haraway, p. 153), they are designed to disappear into the background; to remain invisible. Satellites hover on the edges of the visible world; as vital elements of telecommunications and Global Positioning Systems (GPS), they provide navigational data that underscores certainty, structuring "the tissue of everyday experience" (Parks, p. 7). In the scientific laboratory, the Atomic Force Microscope quantifies invisible forces for the measurement and manipulation of objects at the nanoscale, increasing the miniaturisation of the technical machines that we now carry in our hands, on our bodies, and (potentially) in our blood. Yet in contemporary society, this invisibility demands critical questioning. Hovering on the threshold of the visible, these technologies prescribe a *technicisation* of Being (Ziarek, 2005) to which we are constantly subject. Pivotal in this context is the mobile smartphone.

The Smartphone

As a tiny, screen-based computer, the smartphone simultaneously engages with a number of convergent and miniaturised media technologies. It shares its "Deep Time" lineage (Zielinski, 2006) with previously distinct visual media, including the televisual (television, video and therefore, pre-cinematic devices) and the personal computer (a separate history, drawn from the typewriter to desktop publishing), coming out of a context of military-technological developments of 20th Century satellite navigation. This convergence of media devices (and media histories) marks the mobile smartphone as a critical tool or instrument that has radically changed our perception and experience of space and communication. As David Berry states:

> "the capacities of calculative systems and devices […] to present the user with predictive media and information in real-time, sometimes to startling effect, has become a normative experience of living in a computationally augmented everyday." (2013, p. 2)

The smartphone can therefore be seen to be an elaboration of the "distant presence" of televisual technologies, with their "endlessly mutable real-time flow of signals" (Blom, p. 54). For users who inhabit these environments the screen is just one aspect of an architecture that seems "increasingly hardwired to human bodies" (p. 58); our bodies simultaneously processing this continuous, live electronic presence as "mediatic atmospheres" (p. 54).

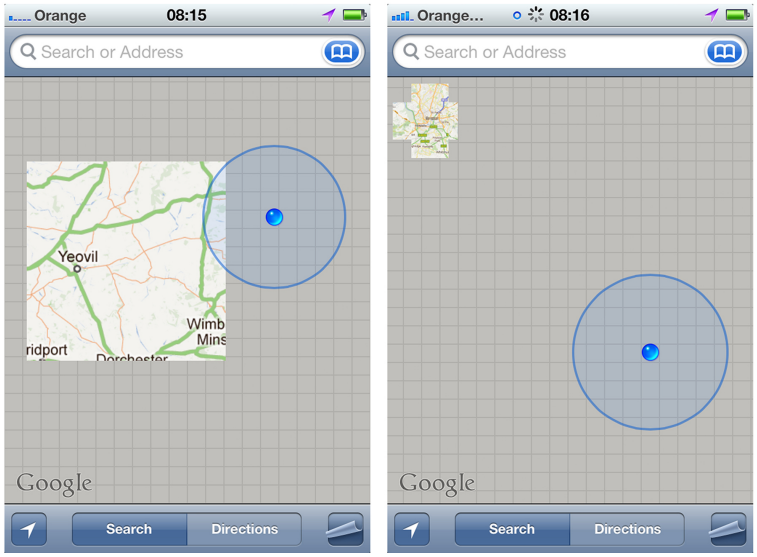


Figure 2: Studio tests (2011) Google maps software on iPhone, intermittent signal. Screenshots from iPhone 4 Smartphone

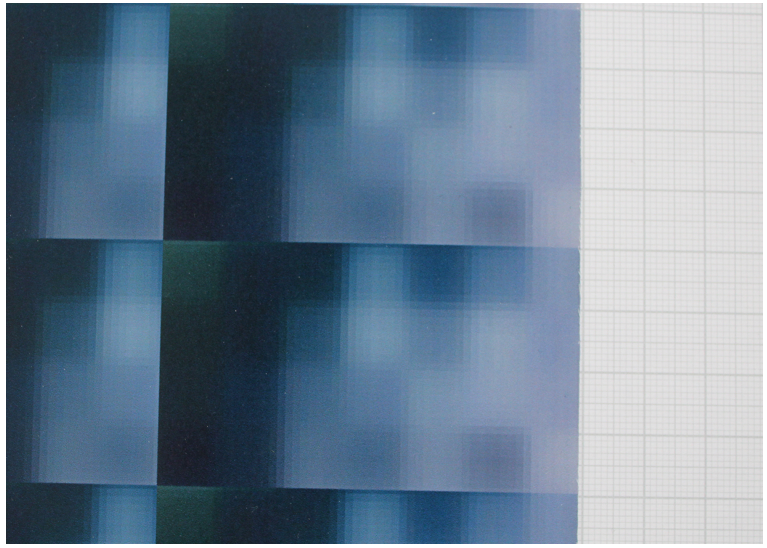


Figure 3: Studio tests (2011)
Google maps pixelated. Screenshot print aligned with graph paper

Due to its direct lineage from the mobile telephone, the smartphone as sender/receiver is not only connected to a global telecommunications network, but is wireless and portable. de Vries writes that:

> "The obvious and single most defining characteristic of wireless communication technology, one that precedes and co-defines its other specific features, is that it renders space almost irrelevant as a variable in constituting mediated contact." (2009, p. 82)

With their omnipresence, wireless communication technologies facilitate the further compression of geographical space into what Manuel Castells in *The Rise of the Network Society,* names as a "Space of Flows" (1996, pp. 405-459). In this space, people, goods and information are in a constant state of flux, moving between physical locations while being part of a dynamic network that is linked together through the use of communication technologies.

Whilst the smartphone is immersed in a culture of connectivity, linked to a vast network of telecommunications structures, mobile phone signal masts, Wi-Fi networks and satellites, simultaneously the materiality of these structures is designed to be invisible, "blended in with the built environment, or situated beyond human perception" (Parks, 2012, p. 196).[2] As de Vries continues, what is significant about this process, is that it appears as a conscious attempt

[2] Later in the thesis I will return to Parks discussion on the politics of Google Earth (see p. 38).

Figure 4: Studio tests (2011) Google maps software on iPhone, intermittent signal. Screenshot from iPhone 4 Smartphone

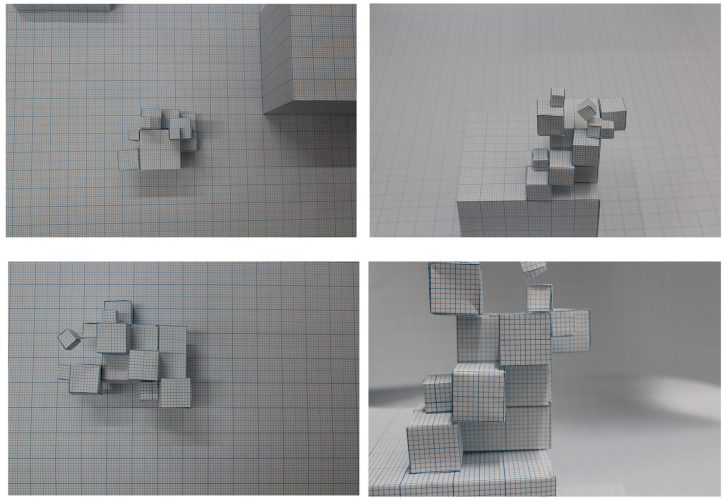


Figure 5: Studio tests (2012)
Pixels and voxels, graph paper

> "to create and uphold the illusion that the wireless connection is 'just there', to be invoked at will to magically synchronise different space and time co-ordinates." (pp. 82-83)

Although the smartphone renders space irrelevant for mediated contact, the same device can simultaneously provide the means to establish exactly where we are at any given time through its communication with the GPS network. Since the end of the Cold War these remote-sensing technologies – originally developed for military surveillance and the 'space race' – have been redeployed to the consumer information industry, resulting in software applications such as Google Earth and Google Maps, using satellite triangulation as a navigational aid.[3]

In the digital space of Google Maps, accessed on a smartphone, geographical space is a never-ending flattened surface; scanned, accessed and framed by the tiny screen; forever looking down on an even plane(t).[4] As Steyerl (2001) states, "the displacement of perspective creates a disembodied and remote-controlled gaze, outsourced to machines and other objects" (p. 8).[5]

[3] See Lev Manovich, (2001) *Language of New Media*.

[4] This figuring of space as gridded continues in the virtual "tiles" of CAD software, and 3D modelling software, Blender and Meshlab – see section on 3D modelling.

[5] See also *Jennifer Allen,* "That Eye, The Sky: How we're getting used to the view from above" (2010).

A user's physical location, mediated through the visual interface of the Google Maps Application,[6] is rendered into a vertical overhead image obtained from satellite data imaging and processes of *remote-sensing.*[7] The smartphone user navigates this interface by touching the screen with two fingers to operate a digital zoom, from the extreme wide-shot of the global map of the earth, into an extremely close-up birds-eye view. The underlying screen image is split into a grid of squares; the image-tiling of the space of the screen, dependent on a Wi-Fi or 3G connection to fill in the pixelated map image-data. The user's location is represented by a constant blue circle or sphere, pulsing to indicate the liveness of the connection.[8]

In a series of expanding and contracting grids, our bodies search for a location. In our quest for orientation, "Where am I?" becomes a quest to find our geographical pixel in the screen-based "space of flows" (Castells, p. 412). This can be seen to establish what Hito Steyerl terms "a new subjectivity, safely folded into surveillance technology and screen-based distraction" (2011, p. 8).

My research project takes place within this context of media communication technologies. Considering extremities of scale, from the orbital to the pixel, my work engages in these questions around the overhead, the three-dimensional, the relation between surface and depth, from the macro to the micro, in the (intimate) positioning of human bodies within contexts of both haptic and remote sensing.

We conduct our daily lives inside these machines, as satellites circumnavigate overhead, and medicine circulates in our bloodstreams. The size and scale of our mediation within computerised systems is both global and nanoscale. It is within this context that my research questions have arisen. I am interested in the ways in which our bodies are positioned by and implicated *in* these technologies; the impact that these charged "mediatic atmospheres" (Blom) have on our senses; and how we are able to coordinate and navigate textures, movements and shifts in perception.

Untitled_Force is my attempt to address these issues through artistic research – through *poetic praxis.*

---

[6] In September 2012, with the launch of iOS6, Apple no longer used Google Maps as the default mapping application in their smartphone OS, but launched their own inbuilt digital maps software - much to the critical disdain of their smartphone community. The Apple software was widely criticised due to its many errors and Apple CEO Tim Cook was forced to make an apology. Google subsequently brought out its own app for iTunes/Apple download, which then was so popular it immediately became the top free download on the iTunes App store (Wikipedia 2013).

[7] Remote-sensing can be defined simply as "the acquiring of data about an object without touching it". (Bhatta, 2011, p. 4)

[8] Location data is gathered from either the nearest phone mast, the local Wi-Fi terminal or the iPhones in-built GPS chip.

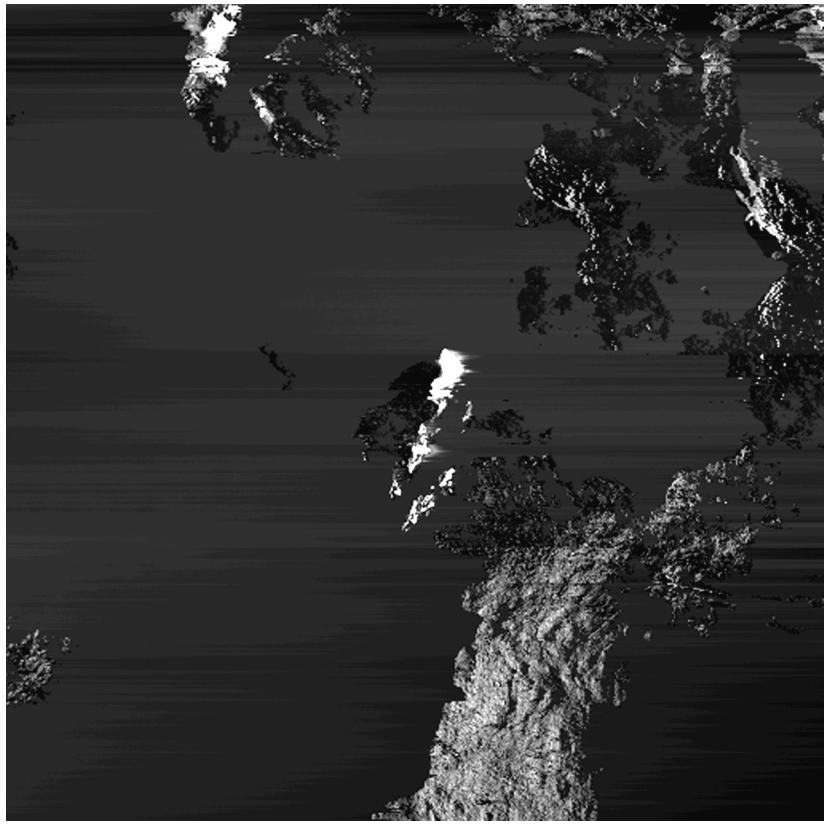


Figure 6: *Untitled_Force.* 50 x 50 µm (2011)
Atomic Force Micrograph of the artist's blood. Original 2D image data

The Atomic Force Microscope (AFM)

The Atomic Force Microscope is a technology that serves both medical and techno-industrial processes, aiding the further miniaturisation of devices, and operating in a biomedical field. It is therefore a technology whose instrumental use spans the biotechnological divide, (the subject of this enquiry).

A microscope is a technical instrument whose etymology derives from *mikrós* "small" and *skopeîn*, "to look at". Invented in 1985, by Binnig, Quate, and Gerber, the Atomic Force Microscope is one of the foremost tools for imaging, measuring, and manipulating matter at the nanoscale. (Nano Science Instruments, 2012). These micrographs are not produced through an optical lens but a scanning process outside the bounds of human perception.[9] A piezoelectric ceramic probe senses the surface of the material sample and measures the *van der Waals* forces between molecules.[10] This information is gathered as the probe scans over the surface of the sample in a repetitive movement, back and forth, taking less than a second. The data is built line-by-line as a raster scan; it takes ten minutes to analyse the tiny sample, producing a data file that can be read both as a flat, two-dimensional image, and as a topographical three-dimensional surface layer or skin. Because the AFM is working at the

[9] [See Appendix 3: Description of Technique and Appendix 4: Photographs of scanning process.]

[10] The van der Waals forces are forces that exist between molecules of the same substance. They are the forces that hold a substance together.

nanoscale, and because of the way in which it generates the image, the picture produced could be said to be *machine-vision*.[11]

Spintronics, (also known as Magneto Electronics) is one of the applications of Atomic Force Microscopy in industry, where it is used to develop the further miniaturisation of computer hard-drives, enabling data storage on tiny devices, including those now used in contemporary smartphones. In biological and medical science, the AFM is used as a biosensor for determining micro- and sub-micromechanical properties at the nanoscale. DNA[12] and RNA molecules up to 2 μm can be observed (S. Kasas et al., 1997, p. 154) alongside the visco-elastic properties of biological materials[13] (p. 158).

The AFM is a highly sensitive technological instrument. Housed in a sealed lab, it demands that its users wear protective lab overalls. It responds to vibrational interference, including the possibility of audio levels in the lab during the process of scanning[14].

- How does data 'meet' the biological or natural?

In considering this research question here, and reflecting upon this physical sensitivity to vibration, to touch, I am invited into a responsive relationship with the machine.

The Haptic: "touching, not mastering" (Marks, p. xii)

In discussing *Untitled_Force* I wish to explore the interrelationship between the digital probe and the physical material. Laura U. Marks articulates a haptic relationship to media, one that rematerialises a sensual bodily engagement with virtual symbolic forms, including "video's body" (p. 147) and "immanence online" (p. 177). Applying Marks' thinking to the AFM as an instrument – as a sensor – can provide a way to poetically reimagine its digital imaging process as a material, haptic relationship; as a threshold or productive boundary space between my body and the machine, to "explore how a haptic approach might rematerialise our objects of perception" (p. xiii).

Marks states the haptic and the optical are not binary opposites but rather "exist in a continuum of sense-making"; the distant vision of optical space and the close attention of the haptic "slide into one-another" (xii):

[11] In this sense it is akin to computerised processes of image-production and analysis, such as those that capture images of deep space through radiography of the infrared spectrum: data visualisation.

[12] DNA is the cell's master repository of genetic information.

[13] Cells are more difficult, as it seems that the scanning tip is a stimulus to the cell and can induce some observable reactions. Monika Fritz (1994) monitored the activation of platelets and suspected the scanning tip to be the activator of the process. (M. Fritz, M. Radmacher, and H. E. Gaub. "Granula motion and membrane spreading during activation of human platelets imaged by atomic force microscopy," Biophys. J. 66, 1328–1334 (1994). Referenced in (S. Kasas et al., 1997, p.156).

[14] Presentation by Dr Paul Thomas at iDAT, Plymouth University 2011. Referenced by Prof. Mike Philips in conversation, 31 October 2012.

> "Optical visuality requires distance […] in a haptic relationship our self rushes up to the surface to interact with another surface […] But just as the optical needs the haptic, the haptic must return to the optical." (p. xvi)

To know by sight, optically, is a different knowledge to haptic understanding, which comes through touch, through making, through materials. "Haptic" comes from the Greek verb, *haptikos*; meaning *to be 'able to touch or grasp'*, and relates in particular to the perception of objects using the senses of touch and proprioception (Dictionary definition 2011).

That the image and data of AFM are created through touch implies a sensation, and a physical relationship that is mutually dependent. There is a tactile relationship between two surfaces that brush up against each other and affect each other. It is through this sense of touch that the topography of the sample is measured. Rather than the distanced and disembodied relationship of sight, feeling is to sense with the skin (the largest organ and a wholly different perceptual apparatus). Thinking about this process as a haptic relationship provides for a sensual encounter between the natural material of my body and the touch of the machine. "In the sliding relationship between haptic and optical, distant vision gives way to touch, and touch reconceives the object to be seen from a distance" (Marks, 2002, p. xvi). We can also figure the haptic as a feminist approach, as Luce Irigaray writes in *This Sex Which is Not One*: "woman takes pleasure more from touching than from looking" (1985, p. 26), and an autobiographical approach: "by engaging with an object in a haptic way, I come to the surface of myself" (Marks, p. 19).

Opening this relationship between myself and the machine to a *haptic reading,* enables us to consider our entanglements and relationships with machines and technological devices on an intimate scale;. here, intimacy is infused with the workings of techno-scientific practice. "The difference between machine and organism is thoroughly blurred; mind, body and tool are on very intimate terms" (Haraway, 1991, p. 165).

This bio-technological relationship originating in the (hidden) lab practices of techno-science impacts on social and cultural practices of the everyday, especially in relation to our material bodies. Haraway continues:

> "in a world so intimately restructured through the social relations of science and technology […] communications technologies and biotechnologies are the crucial tools re-crafting our bodies. These tools embody and enforce new social relations for women world-wide." (pp. 164-165, re-ordered)

At this micro-level of activity, of intimacy, operates the constant drivers of miniaturisation; making devices such as the smartphone, smaller. Considered in relation to my research questions, we see that the Atomic Force Microscope is one technology used in contemporary industry that probes this space between the digital and the biological. As a result of this, *Untitled_Force* opens out onto an imaginative space, or territory, between the two.

AFM as Performative Practice

Following on from this haptic engagement and these intimate relations, I would like to consider working with the AFM in the lab as we might consider an event, or a performance. Seen within the performative idiom, the resulting data file *Untitled_Force* is no longer a scientific representation 'of blood', but instead becomes documentation of a specific (moment of) encounter between my body and the probe of the microscope, in the space or *site* of the lab (see photos, Appendix 4).[15]

> "Live performances are intensely alive in their transitory ephemerality and then continue to work in the world through the traces they leave behind, through their retellings […] as the originary act moves through the reimaginings of dissemination." (Warr, 2012, p. 16)

Bringing this *performative* understanding of scanning (within the lab) to the practice is not only fruitful in an arts context, but it also opens a way of thinking toward performative (lab) practices in a scientific context. It "takes account of the fact that knowing does not come from standing at a distance and representing but rather from *a direct material engagement with the world"* (Barad, 2007, p. 49).[16]

Enacted at a particular time and located as a specific encounter, the scanning activity initiates a series of documents emanating from the event; silently transmitting this ever-mutating performance, in retrospect. To re-quote Haraway, "it is no longer clear who makes and who is made in the relation between human and machine" (1991, p. 177).

The 'Truth' of the [resulting] image, as Documentation

In considering *Untitled_Force* as documentation of this encounter, how then could we consider the resulting data? In *Entering a risky territory: space in the age of digital navigation* (2010), Bruno Latour states that once an image file has left the context of the lab, the scientific method and its cascade of data sets, it loses any claim to objectivity and to (scientific) Truth. Entering a different circulation, then, "an isolated image loses its scientific or referential character and enters a totally different trajectory" (Latour et al., 2010, p. 588). In this context, where technology, art and the imagination meet real phenomena, the data collected is no longer scientific evidence, but rather "poetic debris which can be analysed and structured at will" (La Frenais, 1994, p. 2).

Taking this performative process of microscopic imaging out of the context of the lab allows us to consider it within artistic research as an act of aesthetic production – *poetic praxis*. As a process of mark-making, it is similar to that of drawing or photography. Working with AFM as an

[15] Two artists who have explicitly considered the lab as a site of / for performance are Kira O'Reilly and Dr Jennifer Willet: see Willet, *Performing Biotechnology: Reimagining inter-artist/interspecies interrelations in the laboratory with Kira O'Reilly* (2013).

[16] Following this way of thinking anticipates a common ground between artistic and scientific approaches, and thus towards the potential for transdisciplinary research. This is an interesting subject area that is outside the parameters of this PhD enquiry. For further reference to performative practice as part of scientific research, see key theorists, Andrew Pickering (1994), Karen Barad (2007) and Ian Hacking (1985) (who recounts the multiple practices of microscopy).

artist calls attention to its process as a physical entity and its way of representing as mimesis.

Taken in isolation, and looking closely at the original AFM scan-image, *Untitled_Force* it is *mimetic* of a landscape; i.e. a map of a territory that may correspond in appearance or likeness, but no longer has any objective validity. "An isolated image has no scientific referent – but it generates […] a virtual image, the 'what' that it is said to be the representation 'of' (Latour et al., 2010, p. 588). This "virtual" image is the imagined territory; the virtual landscape that exists in the mind (of the viewer). "The very notion of territory is nothing but the 'virtual image'" answering "a mimetic interpretation" (p. 590).

If we think about this in relation to *Untitled_Force* in particular, despite its absolute microscopic scale, this constructed image visually references satellite photographs of the Earth's surface. However, the biological subject (matter) of the image itself creates an oscillating sense of scale, permitting a conceptual space – an interior landscape of the body – to open up.[17]

Placed within the context of contemporary art, *Untitled_Force* therefore becomes doubly mimetic. It appears to be an aerial perspective map of real space, yet it is operating at a tiny scale. The image is not what we assume it to be representative 'of', nor is it even 'representational' in a direct or optical sense, because of the process by which the image is made. This image offers a space for a territory that is a tiny window onto a much larger imaginary plane, one whose interpretation is entirely open, presenting possibility and leading, therefore, to *the art of the open* (Quasha and Stein, 2000, p. 216).

What *Untitled_Force* as an image highlights is the way that objects are represented through the technology of the AFM. We are not looking at blood as such, but how this scientific instrument has modelled the blood in this particular event, as an image and data set. We are therefore not looking at the scientific Truth of an objective view on blood at the microscopic level, but instead at Atomic Force Microscopy as a method of image-making, drawing attention to its materiality and method. After Heidegger, we are considering the "essence" of the AFM – the *poetics* within the *techné* – and resisting "the will to master it" (p. 32).

The images produced by the Atomic Force Microscope, once out of their original context, become mysterious and ambiguous. They present a view onto an unfamiliar world – grainy vistas reminiscent of the moon's surface, or those of distant planets – yet they are also inseparable from the machinery that created them. They resonate with their media-specificity, embedded within the frame.

[17] Helen Chadwick's "Viral Landscapes" explore a similar subject - see Chapter 3: Artistic Context.

As a digital image, *Untitled_Force* offers up a landscape; an aerial view; a perspective from, and at, a distance. When read as a landscape without a context, we may believe as viewers that we are looking at the Earth's islands and land masses as seen from a satellite; we may try to make out the shapes of the coastline, the figures of islands, the ground, the ocean. This encounter demands a questioning from the viewer, for reassurance, possibly, for certainty, to know. It is impossible to see this as an isolated image, then, as it demands a context. To understand the medium is impossible without grasping its relations to other media, both old and new.

Placing this image in a wider context of technologised vistas, such as the aerial view and satellite imaging technologies, throws up interesting parallels between the act of looking through and at different media technologies, and the contexts in which they're embedded:

> "Our sense of spatial and temporal orientation has changed dramatically in recent years, prompted by new technologies of surveillance, tracking, and targeting. One of the symptoms of this transformation is the growing importance of aerial views: overviews, Google Map views, satellite views. We are growing increasingly accustomed to what used to be called a God's-eye view." (Steyerl, 2011)

Following on from Steyerl, in *Zeroing In: Overhead Imagery, Infrastructure Ruins and Datalands* (2012), Lisa Parks discusses the politics of Google Earth and Google's intellectual copyright on NASA Satellite data. Her essay continues her research into technologised acts of distant observation where the displacement of perspective creates a disembodied and remote-controlled gaze, outsourced to machines and other objects. This highlights the very real need to be aware of the frames through which we perceive our location, the knowledge industries that construct these images, and thus our perceptions of "self" in these space(s).[18] We can think about this in relation to the image from a microscope, which is an instrument for observing, viewing, or examining: *skopeîn* not only means to look at, but also derives from the Greek *skopos* meaning "target".

Frames of vision are governed by *technics*. The overhead image refers to data that has been acquired by instruments on-board satellites, rendered by computer software, and composited to present a particular point of view. We can think of this image as a target, as it directs one's attention and focus to a particular site constructed from the perspectives of (militarised) aerial and orbital machines. This "God's-eye view" (Steyerl 2011) is the visualisation of a set of frames denoting power, which Heidegger also names *enframing*. These acts of *enframing* are useful for understanding

> "the production of knowledge and the materiality of communication because they draw attention to such issues as the weaponisation and commercialization of frames and perspectives, the transformation of sovereign territories into navigable digital domains, and the accumulation and circulation of new forms of intellectual property." (Parks, 2012, p. 196)

[18] Our perceptions of "self" in space: exteroception, proprioception.

Figure 7: *Untitled_Force* pictured as a map on smartphone (2015)

We can think about this in relation to the technicisation of science, as a context whereby images are made and produced within the black box of the lab environment, and uncritically received in the wider context of visual culture.

Untitled_Force as a 2D image – in framing both technologised vistas: the micro *and* the macro, the minute and the vast – simultaneously operates a transformative relationship with the technological, providing an opportunity to think about knowledge practices and the materiality of media and representations by bringing infrastructural and representational processes to the fore.

Introducing the body – as material, as blood – into this frame, reveals a vertical power structure and the *technics* of control. In a reversal of perspective, it reveals a critical awareness of the vertical space that stretches from the centre of the body (or bodies), through the atmosphere to the orbiting satellites and down to the scale of sensation (the touch of the force between molecules), highlighting the medical and navigational instruments of technology that our bodies both inhabit and are inhabited by.

Untitled_Force invites us to look at the technology as *poiésis* rather than as *techné*. Through this approach, the AFM becomes a contemplative medium, rather than a tool or an instrument. The work reveals "what comes to presence" in microscopy (Heidegger, 1977, p. 10). It pushes the

subject further away; nature is no longer *En-framed* as *standing reserve,* but is revealed as something that oscillates in the distance. The *thing* is irreducible to what we represent of it, and once again becomes mysterious, poetic.

In considering how data meets the biological or natural, this tiny scanned surface is smaller than a pixel on the iPhone screen: the size of the blood scan is pixel-scale. Yet placing the work in a context of satellite vistas within the smartphone enables us to consider *Untitled_Force* as a contemporary figuration; a form of map-making for a hypothetical interior Landscape. Within our mediatic atmosphere, it becomes a concealed, yet expansive terrain. To paraphrase Caroline Jones, this aesthetic practice both locates *how* our bodies interact with technologies at the present time, whilst providing a site for questioning these locations (2006, p. 2).

Chapter 3:
Artistic Context

Introduction

Where the preceding section introduced my research project, this chapter will present the work of artists who have approached similar research themes – namely those of the body and its relation to technology – asking how to articulate these concerns through a focused, explorative and recombinant practice.

At the heart of these investigations is an acknowledgement of a profound shift in material relations from an industrial to a post-industrial society. As Lev Manovich predicted in 2001:

> "While from one point of view, computerised media still displays structural organisation that makes sense to its human users [...] from another point of view, its structure now follows the established conventions of the computer's organisation of data. [...] These dimensions belong to the computer's own cosmogony[1] rather than to human culture. *New media can be thought of as having/consisting of two distinct layers – the "cultural layer" and the "computer layer". We may expect that the computer layer will affect the cultural layer.*" (p. 46, my emphasis)

Ten years after Manovich wrote this, when I started this research project in 2011, information and computational processes had begun surfacing

[1] Definition. the machine's origin/creation myth.

within culture and real-world experience[2] to a significant extent, as the ubiquitous use of digital devices (laptops, smartphones[3] and GPS) started to infuse the senses; to frame experience and have profound perceptual implications for our bodies' understanding of and navigation through space.[4]

It was through my perception and experience of these factors that the questions for this research project were generated, as I became fascinated by the relationship between the digital and the biological. However, my awareness of these devices, creating "mediatic atmospheres" (Blom, 2006, p. 54), was also enhanced by the time I'd spent as an artist in residence at iDAT (Plymouth University), and in the Synthetic Biology lab through the project with Arts Catalyst. Both of these residencies had afforded a glimpse into a miniaturised world where code and cellular activity were now becoming indistinguishable.[5]

As I started to question the material relationship between the digital and the biological, James Bridle initiated the "New Aesthetic Project" as a Tumblr blog; "collecting images and things that seem to approach a new aesthetic of the future" (2011). Bridle structured his use of the term around the notion of machinic vision: "the God's-eye view of satellites…the pixellation of low-resolution images, the rough yet distinct edges of 3D printing, the shifting layers of digital maps" (Bridle SXSW, 2012, quoted in Berry, p. 3).

At the time, Bridle's claims generated much contested debate within academic circles, especially regarding the "New-ness" of such practices.[6] However, Bridle himself often appears to celebrate this zeitgeist, rather than critically assess the impact of the online, digital or virtual sphere, "computational culture" (Berry 2013), and its relations with the material reality of the offline. Indeed, on being questioned by the author on this subject, he refuted the very need to engage with this material, tactile element.[7]

Nevertheless, the "New Aesthetic" is now often used as a term to refer to the increasing appearance of the visual language of digital technology and the internet in the physical world; *the blending of virtual and physical.*

[2] My understanding of "culture" is following Raymond Williams, as the "structure of feeling".

[3] The first Apple iPhone launched in 2007.

[4] This was the motivation behind the work *PURE FLOW* (2009), and *PURE FLOW 2.0* mobile edition (2011), which was developed to function as a kind of '*perceptual field*' - see Appendix 1.

[5] I will discuss this further in the next section on Methodology.

[6] Discussions online (CRUMB), at academic and creative industries' conferences (SXSW, Transmediale, etc.) have considered the term "New Aesthetic", the term given to the emergence of the digital, online realm into social and cultural life and the effect this is having on design practices and architecture.

[7] "I refuse to privilege the physical tactility of 'things' over the digital" (James Bridle, responding to a question posed by the author, BU Emerge 15 May 2013). See Appendix 5: This was during a series of presentations/discussions titled, 'Art in the Expanded Field; Digital Media, Networks and Technology' organised by the author as part of CoLab / Emerge research practice at BU. 2013.

As David Berry stated at *Transmediale* in 2013:

> "the new aesthetic has served as a lightning rod for general recognition that our computational way of thinking is (finally) having a major influence on socialities, work and life itself." (Berry et al,, p. 2)

As I developed my research I started to discover that artists have been critically exploring this area through practice and on-going artistic research for many years. I am including as part of the exegesis, therefore, two case studies of relevant work and practitioners: *Viral Landscapes* (1988-89) by Helen Chadwick, and London Fieldworks' *Null Object* (2012). Although they were created twenty-six years apart, both works were recently selected for the exhibition *The Negligent Eye,* The Bluecoat, Liverpool (2014), which also reflected upon the impact of digital technology.[8]

In contrast with Chadwick's *Landscapes,* which present a series of large-scale, colour photographic prints, London Fieldworks' *Null Object* is a sculptural object that specifically negates image or form. However, both works consider the relationships between the body and contemporary science, digital technologies, and an embodied position within the geological and social landscape.

Writing on the work in 1989, Helen Chadwick describes *Viral Landscapes* as "territories of a prolific encounter, the exchange of living and informational systems at the shoreline of culture" (p. 97). Similarly, Bruce Gilchrist (whose work *Divided By Resistance* was first installed at the ICA in 1996) articulates the computational layer as a new "unconscious" of the social: "databases, ticking along in the background, like society's unconscious" (London Fieldworks 2013). [9] Both of these works, therefore, provide a critical context for my research questions:

- How does data 'meet' the biological or natural?
- At what points does the digital become material?
- What happens in this space: the surface tension between the digital and the material?
- How does the body re-encounter or re-engage with this material, this fabric?

[8] The exhibition, curated by Jo Stockham, Head of Printmaking at RCA, reflected upon digital technology and its impact on how we picture the world; "*The Negligent Eye* reflects how a younger generation of artists is questioning the impact of digital technology on humans. The exhibition also includes older, seminal works showing earlier experiments by artists using computers and electronic reprographic processes." (*The Negligent Eye* 2014)

[9] I discovered the work of London Fieldworks through taking part in a seminar *Translation: Pairing Practices* (London, June 2012). My reflections and response to this were published in "The Journal of Writing in Creative Practice, (2013) Volume 6: Number 1: *Translating Practice.* (Bristol: Intellect) pp. 127-133.

"The solitary repressive ego, harnessed in language, is sovereign. Sense has subjugated sensation. What if *dangerous fluids were to spill out*, displacing logic, refuting a coherent narrative, *into a landscape on the brink of I*."

Helen Chadwick *Enfleshings*
(1989, p. 29, my emphasis)

Viral Landscapes

The artist Helen Chadwick (1953–1996) investigated matter, materiality and the body through her often autobiographical and highly formalised practice. In her own words:

> "I was trying to open up a territory for desire, how to depict desire and physical sensation and pleasure and given that one's experience of that is through the body it seemed to me that the body was central to the project." (*The Art Of Helen Chadwick,* 2004)

Chadwick's conception of the body is as site, not object: "a site no longer defined primarily by the physical boundary of the body but as an a-centric, boundless field" (Stephen Walker, 2013, p. 54). Chadwick's work, then, interrogates the body from the inside out, in an epistemological search, dissolving boundaries and uncovering materiality. Her ambition: to reinvigorate the role of the body, to shift it out of its "furtive, private half-life" into "spectacular materiality" (p. 54).

The particular works that I focus on here are the large-scale prints *Viral Landscapes* (1988-9), which were pivotal in the key shift in Chadwick's work from figurative representations of her own body to depictions of a microscopic attention; the corporeal interior, both within the landscape and, in her later works, within the lab.

Figure 8: *Viral Landscape Number 1* Helen Chadwick (1988-89)
C-print photograph, powder-coated steel frame, aluminium, plywood, Perspex
300 x 120 x 5 cm

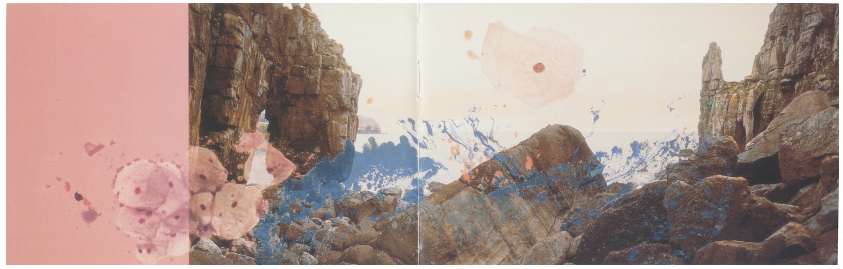


Figure 9: *Viral Landscape Number 3* Helen Chadwick (1988-89)
C-print photograph, powder-coated steel frame, aluminium, plywood, Perspex
300 x 120 x 5 cm

The Viral Landscapes are a series of five framed colour printed photographs, each measuring 120 x 300 x 5 cm. These are large-scale composite prints, framed in powdered steel. They are made of multiple layers, bringing together several perspectives simultaneously; they not only document sections of the Pembrokeshire coastline, but also Chadwick's position within the landscape. The prints reveal traces of her performative body and her body as site. As composite works, they document the embodied artist within a social, technological and environmental landscape.

The works were made in response to a commission and residency in the Welsh National Park. Chadwick took huge canvasses to the shoreline and wrestled with them, pouring paint into the sea. The resulting marbled patterns echo the fluid forms of the waves as they rise and fall onto the land. She used scrapings of cells from her own body, photographed microscopically, layering these over both the photographic documents of the coastal landscape and tidal stains, in order to complete the works. Using contemporary image-processing tools, Chadwick compressed and flattened the layers together into a two dimensional image, before framing them using a weighty material. [10] The cellular layer posits the highly magnified, microscopic images of her own bodily tissue over the images below.

[10] Chadwick was profoundly interested in the relation between 2D and 3D.

Figure 10: *Viral Landscape Number 5* Helen Chadwick (1988-89)
C-print photograph, powder-coated steel frame, aluminium, plywood, Perspex
300 x 120 x 5 cm

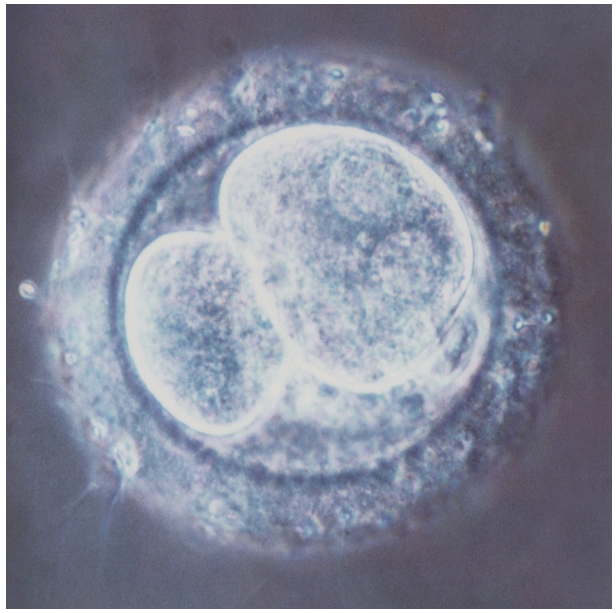


Figure 11: *Nebula (detail)* Helen Chadwick (1996)
C-print photograph, Perspex mount.

These works, as documents of Chadwick's presence in the landscape, offer a multi-perspectival viewpoint for the audience; combining microscopic body matter with the geological formations of the rugged coastline and the stains of her performative interactions in these spaces.

> "Unlike previsualisation … layering occurs after the event, a compilation and orchestration of elements, not necessarily as montage, but always an assembling and articulation." (Cubitt, 2014, p. 192)

Chadwick wanted to dissolve the body as site; to reveal the poly-scalar existence within and beyond the flesh of containment. As images they document the coalescence of body, culture and technology. Drawing from this techno-corporeal imagery, Chadwick explores the internal/external borderlines of the body; offering a meditation upon interiority as a permeable boundary, and documenting the fluid materials passing through and over these porous surfaces. Rosemary Betterton (1996) locates these concerns in relation to Kristeva's notion of the 'abject':

> "the abject is 'the place where meaning collapses', the liminal, the borderline, that which defines what is fully human from what is not [...] The most significant borderline is that which separates the inside from the outside of the body, self from Other." (Betterton, 1996, p. 133)

Here, Chadwick, like Haraway, argues "for *pleasure* in the confusion of boundaries and for *responsibility* in their construction" (Haraway, 1991, p. 150).

As a practice-based researcher, Chadwick's visual work and her writings have a symbiotic relationship: each vastly expanding the appreciation of the other. In articulating her work she wrote prolifically, as this extract from *Enfleshings* illustrates:

> "*At its most intimate, the abolition of frontiers renders my body up as cells and tissue, vulnerable to manifold incursions. Released from the bonds of form and gender, flesh is volatile and free to wander […] The living integrates with other in an infinite continuity of matter, and welcomes difference not as damage but potential. […] Spliced together by data processing, these are not ruined catastrophic surfaces but territories of a prolific encounter, the exchange of living and informational systems at the shoreline of culture.*" (1989, p. 97)

Prefiguring contemporary culture, this "shoreline" can be found in microscopic investigations and in amongst a "froth of code":

> "digital devices plunge us into a froth of code that becomes progressively less intelligible to humans as it moves closer to the point where it is instantiated in the materiality of the machine." (N. Katherine Hayles, 2006, p. 194)

What I find most interesting in Chadwick's oeuvre, in her writings, is how she articulates the ways in which her body recombines with this machinic element. In writing on an earlier work, *Of Mutability* (1984-86), Chadwick describes her experience of placing her body upon a photocopier, in "the callous intimacy of the reprographic […] physicality is reduced to surface, a mere echo of itself, the corporeal imploded into grains of dust [...] particles recast into diagrammatic fields radiating outwards from a notional centre" (1989, p. 29). In an interview with Mark Haworth-Booth (1994) Chadwick states that *The Viral Landscapes* series enabled her to document

> "the consequence of the body being open to things beyond it which are not like it, and the consequences of a potential synthesis of some kind of informational matter that's not human, and the human."

From this statement we understand that Chadwick's intentions were similar to those of Stanisław Lem when writing *Solaris;* for a human encounter with something that exists, yet "cannot be reduced to human concepts" (2002). This too is the area of my research project: articulating how data 'meets' the biological or natural, and considering this threshold, liminal space; this space which, after Kristeva, can be considered as 'abject'.

However, many of Chadwick's investigations remain resolutely as photographic images, and this is where our research practices differ. [11] Shortly before her death in 1996, Chadwick completed a residency at the Assisted Conception Unit at King's College Hospital, where she immersed herself in the intricate, lab-based processes behind IVF technologies, working on a series of microphotographs of human pre-

[11] Chadwick's work *Blood Hyphen,* (1988) an installation built within and above a church/medical mission in Clerkenwell London, uses a laser and micro-photographs of cell tissue from the cervix. This is an admirable work that moves away from the photographic in its use of material and spatial installation.

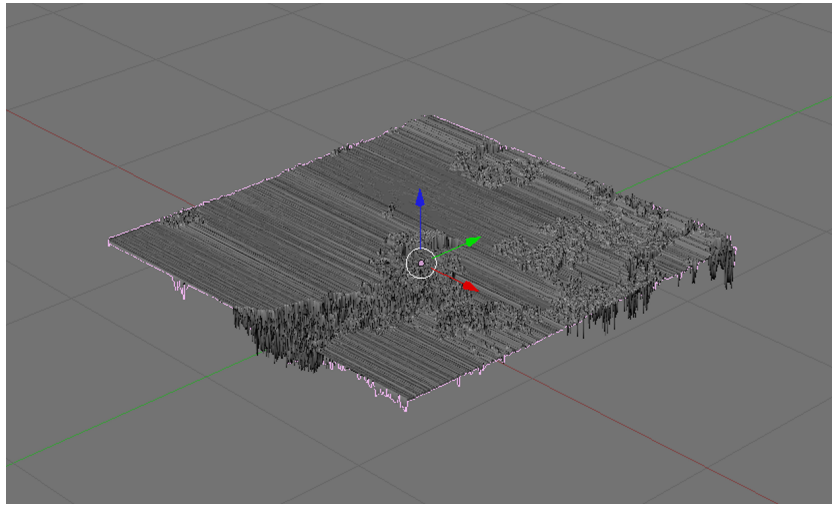


Figure 12: *Untitled_Force* in *Blender* 3D modeling software (2012) Screenshot

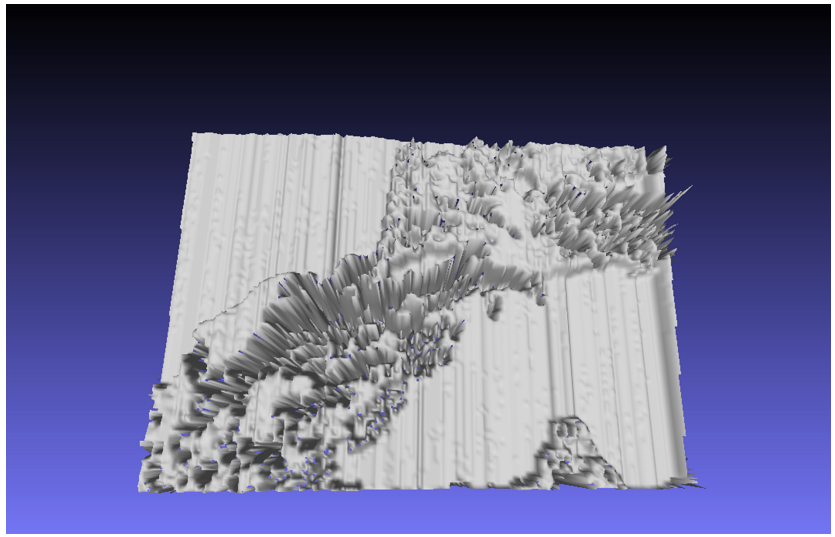


Figure 13: Fragment 5 of *Untitled_Force* in *MeshLab* modeling software (2012) Screenshot

embryos (Buck, 1996). [12] With her untimely death, it is difficult to predict in what direction Chadwick's work may have led, especially given the profound developments since, both in contemporary digital media processes and practices of techno-scientific research.

Although, like Chadwick, my artistic research considers how my body engages in an intimate relation with the machine, in the contemporary culture of mobile smartphones, satellite networks and computational society, I feel that the photographic image alone is no longer able to adequately convey the enormity of the shifts into these vast territories of the digital; into what could now be named as the technological sublime.

Whilst I have an incredible affinity for Chadwick's work, *Untitled_Force* is a distinctly different contribution to knowledge. In working directly with data that is derived from the lab-based process of Atomic Force Microscopy – a process which I articulate as a tactile or haptic sensing, a probing of blood at the nano-scale – I am taking this data through different material processes, and away from the representational, photographic image.

This is the unique aspect of my research: in developing a body of work that explores an intimate relationship between my blood and the

[12] Having renewed significance as a recent request (Sample 2015) was made by UK scientist to use genetically engineered stem cells using similar kind of embryos (IVF rejects). Update: Feb. 2016 a request to genetically modify human embryos has just been granted in the UK. (1st Feb. 2016) (Siddique 2016)

machine, through poetic praxis I consider how the materiality of my body is translated, dispersed amongst the non-representational "froth of code" to become fabricated through techno-scientific processes. These articulations can be read as my "Enfleshings"; a virtual fleshy materiality. One smear of blood on the slide, examined and probed by the machine, conjures up a landscape of immense proportions; enormous folds of matter, skin, and a surface "without thickness" (J. Bradbury, p. x, Appendix 6); a monstrosity floating in a virtual space. After Helen Chadwick, however, "let this model […] be infused with a poetry of feeling and memory":

> "Inside is outside is inside. The eye reads these signals in the cool, far retinal distance. Yet they occurred and are still in the knowing realm of touch. Intimate events of the moment of contact, happening once, are continually secured in place."
>
> Helen Chadwick, *Soliloquy to Flesh* (1989, p. 109)

"Human beings in their embedded situated life constitute *a topographical place* (the body, the self) where procedures and gestures can be carried, to directly explore human experience itself (the quest) [...] In the traditions of human wisdom (most notably Buddhism Hinduism and Taoism) this portable self-laboratory is the place for human discovery and transformation."

Francesco Varela,
quoted by Jo Joelson
(London Fieldworks, 2013)
(my emphasis)

Null Object

In this section I present the work of artists London Fieldworks whose artistic research engages with science, poetics and technology. London Fieldworks are artists Jo Joelson and Bruce Gilchrist, whose work is focused on "the relationship between creative research and practice at the intersection of art, science and technology" (Joelson at London Fieldworks, 2013). Over the past decade they have been making works that probe a relationship with the natural world; projects involving field-based research and residencies, often in remote and rural areas, including northeast Greenland, northern Norway and Brazil.

These projects carve out a space where natural phenomena can be apprehended through disciplines that converge, providing a multi-perspectival viewpoint. Approaching phenomena from this elliptical position means that subjects can be grasped through means that are both ancient and contemporary, folding together (peripheral) scientific research in combination with artistic research activities and a sensibility to materials, process, performance and presentation.

As Tracey Warr writes, "Gilchrist and Joelson's work clarifies an enquiry into the unknown that is the common, fundamental notion of art, science and exploration" (2002, p. 7), whilst preserving a sense of wonder that inspires both disciplines.

Figure 14: *Null Object: Gustav Metzger Thinks about Nothing.* London Fieldworks (2012) Portland stone, 50 cm^3 200 kg

London Fieldworks' artistic research explores ideas linking mind and weather, mediated experience and "the juxtaposition of ancient and modern, through augury, premonition and knowledge" (Joelson, London Fieldworks, 2013). A number of similar concerns have run through their projects, in particular "the shift brought about by technological advance; making connections between myth and science, environmental cues and technological control; the virtual worlds we imagine and the real world we cannot escape" (Joelson, London Fieldworks, 2013). More recently, their concerns have focused on nature's place in culture; the way science and technology is challenging our relationship to both the inner as well as the external landscape.

In this case study I will be looking at their most recent work, *Null Object: Gustav Metzger Thinks about Nothing,* making reference to their previous projects, such as *Little Earth* (2005) and *Outlandia* (2008). All are multi-layered projects that marry practices of artistic research with scientific forms of apprehending the world, to produce what Hito Steyerl calls an "aesthetic of resistance" (2012, pp. 55-62) as radical epistemological practice.

Null Object[13] (2012) is a highly complex and densely layered work. Made in collaboration with a team of specialist robotic engineers, neurophysiologists and computer programmers, at the centre of the

[13] In object-oriented computer programming, a *Null Object* is an object with a defined neutral ("null") behavior. The *Null Object* design pattern describes the uses of such objects and their behavior (or lack thereof). (Wikipedia 2013)

work is the figure of the artist Gustav Metzger whose function, according to Gilchrist, is "as a kind of neurophysiological trigger" (Gilchrist, quoted in Connor, 2013, p. 129).

The *Null Object* in this work is a void drilled from a large cube of Roach Bed Portland stone measuring 50 cm^3. Created by industrial manufacturing technology linked to a computer-brain interface, *Null Object* is a combination of material stone and immaterial thought-forms, and also draws from Gustav Metzger's long career as an artist. The work makes connections between the absorption of the computer into societal processes, articulating a void; a space for the preconscious and the unknown; coupling Metzger's work on the concepts of emptiness and the voidance of nature (Metzger, Auto-Destructive Art 1951-69) with London Fieldworks' 'perceptual databases'.

The work is led by Gilchrist's perception of the burgeoning role of databases across all sectors of society; as if the database is quietly ticking along in the background, keeping things running, "almost like society's subconscious" (Gilchrist, London Fieldworks, 2013). Aligning the unconscious of the body with societal processes of database computation can be read through the work of Haraway (1991) as a further articulation of the cyborg: the immersion of Gustav Metzger's thought forms in Gilchrist's perceptual database produces a cyborg whose function is to visualise Gustav Metzger's thoughts; this is what he 'sees' when he thinks of nothing.

Key to the work of London Fieldworks is the concept of the "body as a mobile laboratory; as a set of instruments and 'as a means of knowing"'. Their participation in the *Laboratorium Project* and its subsequent publication, curated by Hans Ulrich Obrist (1999), introduced the duo to Chilean biologist, philosopher and neuro-scientist Francesco Varela, and his concept of the body "as a portable laboratory".

EEG recordings have featured throughout the work of Gilchrist (later as London Fieldworks) since *Divided by Resistance* (ICA, 1996). The bespoke database software developed by Gilchrist with programmer Jonny Bradley was prompted by a research visit to the Clinical Psychology Department at the University of Texas (1993), where Gilchrist was introduced to the methodology of the sleep lab and the principles of biofeedback. In the projects *Polaria* and *Syzygy,* EEG recordings both reveal and question this relationship between the exterior environment (such as Greenland or the Sanda Isle in the Southern Hebrides, Scotland) and the interiority of the artists' own bio-processes.

This collection of psychophysical data, this perceptual database, is then used as a *relational* database; as a 'fabric', a materiality, from which Gustav Metzger's readings of "thinking of nothing" can be ascertained and extracted.

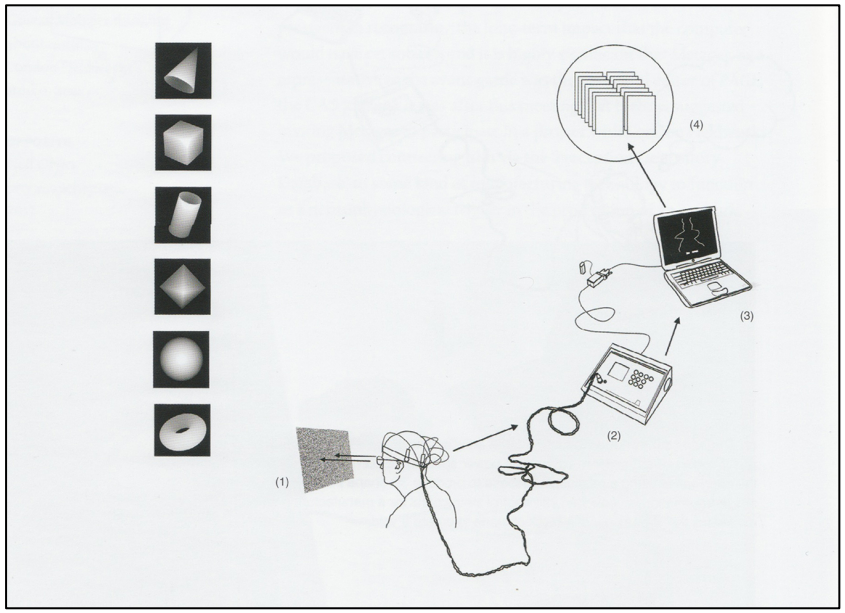


Figure 15: *Null Object Process Schematic "Looking at Primitives"* (2012) London Fieldworks

Gustav Metzger's thought-forms, coupled via this perception depository 'database' to an industrial manufacturing technology, drill out a relational void in fossilised stone. There is a sequence of translations from human thought to computer data to machine action, to produce a sculptural object.

The work articulates a paradox using the objective approach of scientific research in relation to entirely subjective perceptual experiences. As a sculptural object, the work communicates the results of this research with a further paradox: that we can't perceive the shape of the void. As an absence of form, it exists only as a subtractive excavation; as a lack – an emptiness – for which we do not yet have a language. In a sense, the work reveals to the audience how much we don't know; – how even the entire history of our knowledge practices is miniscule, a fraction of time when compared to the fossilized remains; the voids left by the marine creatures and Portland screws that inhabited the world 150 million years ago, yet which, through a kind of temporal montage, sit side-by-side with Metzger's excavation.

Considered from the contemporary context of technologies that are designed to disappear into the background, to remain invisible,[14] we can see that *Null Object* makes an important link between the unconscious processes of the body and society's unconscious of digital computation.

[14] Lisa Parks states this materiality (of communication) is designed to be invisible: "blended in with the built environment, or situated beyond human perception". (2012, p. 196).

Figure 16: *Null Object* (detail) London Fieldworks (2012)
photo: Katy Connor

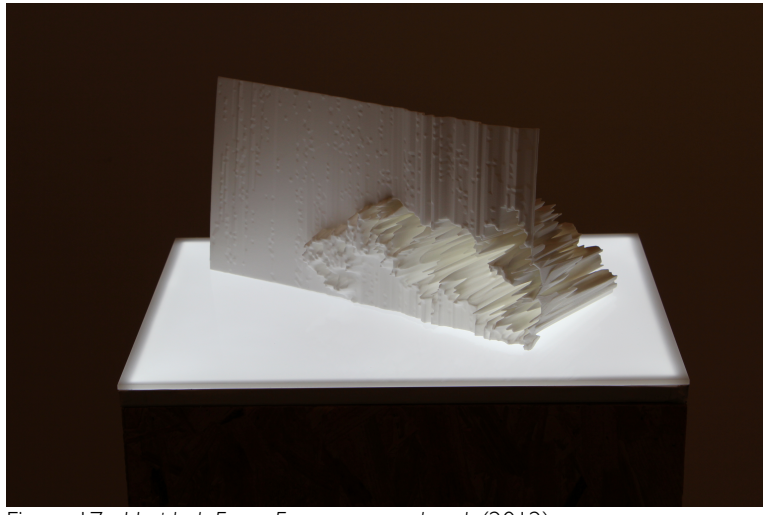


Figure 17: *Untitled_Force Fragment number 1* (2012)
Nylon 12

Mediated through devices that *shape* our behaviour and thought processes; sculpting our actions like the roboticised drill carves out the void of Portland rock:

> "code/software today is a key mediator between ourselves and the world we encounter, disconnecting the physical world from a direct coupling with our physicality […] the condition of the calculative media environment we increasingly experience – as computationality – with digital devices augmenting our perception and cognitive forethought to such an extent as to shape the very possibility of human thought…the cognitive processing of what are now huge databases of personal and cultural entities, stored in servers around the globe, creates a new co-constructed individual on-the-fly." (Berry et al., 2013, p. 21)

By aligning these invisible processes with human thought, *Null Object* explores the unconscious as mediated through quantitative scientific process coupled with machine sculpture – commenting on the extent to which we, as a society, are now engaged in processes possibly beyond our knowing or our will, as our perceptions are modified. Tracey Warr writes that these artworks "journey into the unconscious, unlanguaged parts of consciousness, into prehension and preconsciousness" in an exploration of "what is in between the language and super-ephemerality of consciousness" (2010, p. 25).

> "Much of our experience exists at a non-linguistic and non-symbolic level, it is not consciously voiced but it hovers on the edge of what is consciously known. This may be retained in the body, in emotion, in soma. Information processing and long term memory are unconscious brain activities." (Warr, 2002, p. 8)

The work of London Fieldworks (and *Null Object* in particular) therefore draws attention to these processes, giving them shape, form and a material weight or gravitas, in sharp contradistinction to Berry's weightless "individual on-the-fly" (p. 21).

The work can be seen as "a contestation of the technicisation of the everyday" (Ziarek, 2001, p. 6) questioning the "techno-scientific modes of perception and their influence upon language and the logic of representation" (pp. 6-7) and, I would add, on consciousness itself.

With my own work, specifically the series of 3D printed sculptures, there is a correspondence between the original reading or scan data of the body, the blood which is itself a physical manifestation of unconscious physical processes. Translating this material through digital software and modelling programmes to produce an object (or series of objects) also gives shape and form to a synthetic object, a visualisation of the contemporary relationship between the body and technology.

London Fieldworks are primarily interested in the body as a source of electrical charges, which can be processed and interpreted computationally. This fascinating body of work re-imagines the holistic body, both as 'signal generator' and processor, blurring any distinction between the body and machinic process. By contrast, my interest is in the corporeal, physical bio-matter of the body; the sensual, material substance; the blood, rather than the electrical charges sensed and revealed by the EEG recordings.

[BLANK PAGE]

Part Two

Chapter 4: Method

Introduction

The following descriptive chapter outlines and elucidates my methodology of artistic research, which developed throughout the course of the PhD. Henk Borgdorff (2010, 2012) clarifies this artistic research methodology as follows:

> "As a rule, artistic research is not hypothesis-led, but discovery-led, whereby the artist undertakes a search on the basis of intuition, guesses and hunches, and possibly stumbles across some unexpected issues or surprising questions on the way." (Borgdorff, 2010, p. 56)

Building upon my experience as an artist (see Appendix 7: Katy Connor CV), my artistic research was guided by an intuitive approach towards making, in combination with reflection on practice; both informed by academic research and critical discussion. The elements of research *through making* took place both in my studio (at Spike Island, Bristol) and in techno-scientific research laboratories at Plymouth and Exeter Universities. Active reflection on the work then took place in wider contexts, through participation in media art events including *Transmediale,* Berlin (2013); academic conferences and research seminars; alongside public events and exhibitions.

My research questions demanded a methodology that could be open and flexible, and combine a broad array of practices, which would enable the process and forms to articulate and develop. The works discussed here therefore engender different skills and methods of working; oscillating between the hand-made, tactile form, and the virtual, technologically mediated construct. I have chosen the term *fabrication* to highlight my multi-faceted approach to this inquiry. The verb encompasses some of the processes that I have engaged with; in terms of crossing and re-crossing textures of digital and physical materiality, engaging both with material processes of production in post-industrial society and thinking through cultural practices of the everyday.

The research questions were developed following two residencies that took place directly before the PhD, both of which were in university lab-based environments that supported artists to explore techno-scientific processes. The first of these was a 12-month artist residency at iDAT, Plymouth University (2010-11), facilitated by Prof. Mike Philips, which enabled me to engage with aspects and instruments of digital technology, including the AFM. Alongside iDAT researchers and technicians we developed a prototype of *Bio-OS:* an Operating System that "allows intimate biological information to be collected from the users body" (iDAT 2011 and 2013).

The prototype was developed to translate the temporal rhythms of the body (such as the heartbeat), into data that could then be used for a number of different tasks, in contexts such as installations, narrative or gaming environments. and also as applications for e-healthcare.

This prototype generated a lot of questions for me about the relationship *between* the body and its digital rendering, especially as a stream of data. To translate the body into a series of digits that could, in turn, power switches, seemed incredibly *reductive.* It appeared, like language and other symbolic systems, to leave a great deal *out* of this equation, and also incredibly mechanistic to reduce the body's experiential substance to an instrumental rendering of a biological function, as Ziarek writes: "being stored, manipulated, and processed as data" (p. 216). *Techné* – instrumental use – is predicated on manipulation (Heidegger, 1977). But what about experience? *Poiésis?* "the data of, depth" (Olson, 1965).

The second residency, *Synthesis* (Arts Catalyst, July 2011), was based at the Department of Structural and Molecular Biology, University College London. [1] In this intensive workshop, facilitated by Prof. John Ward with artists Daisy Ginsberg and Oron Catts (SymbioticA), I was exposed to the multifarious aspects of Synthetic Biology, as part of a group of selected artists, biologists and engineers.

[1] The four partners were The Arts Catalyst, London; UCL with the EPSRC funded Synbion network; Synthetic Aesthetics (Universities of Edinburgh and Stanford, CA) and SymbioticA, (Centre for Biological Arts, University of Western Australia). *Synthesis* was funded by a Wellcome Trust Award.

> "Synthetic Biology […] offers a future fashioned by engineering logic, a rational approach to the complexity of living systems powered by a binary vision of the world around us […] the aim is to 'make biology easier to engineer'. Promising new drugs and materials for medical applications, new routes to making biofuels and chemicals and enabling the building of novel genomes and cells, it could have profound implications for the way we perceive and use living things." (*Synthesis Handbook,* Ginsberg, 2011, pp. 10-11)[2]

These two residencies ignited my interest in themes of the bio-technological, coming out of a vital and contemporary social context, in which the research could potentially have value. Together they generated the ground and the space for the research questions, and motivated me to include working within a lab context as a vital element of the research methodology.

I therefore developed my artistic enquiry through a reflective and critical approach towards the techno-scientific processes of Atomic Force Microscopy (AFM), and Additive Layer Manufacture (ALM) (commonly known as 3D Printing). This incorporated modes of observation, reading and reflection; working within scientific laboratories and engineering environments.

Aims and Objectives for the Research

The aim of the research project was to address and explore through the process of artistic practice, the sensation of a boundary or threshold space between the digital and the material (biological or natural) fabric. My objectives were to produce a series of objects or artefacts that would concretise (and embody) this space in material form, through the methodology of artistic research.

Research Questions

To restate my research questions here, they are;

- How does data 'meet' the biological or natural?
- At what points does the digital become material?
- What happens in this space: the surface tension between the digital and the material?
- How does the body re-encounter or re-engage with this material, this fabric?

I wondered then if a more *poetic* approach – *poetic praxis* as outlined in Chapter 1 and generated through artistic research – could bring a new understanding to these questions? Could this also give a purpose to the research? As Borgdorff states, artistic research is "an undertaking whose purpose is to articulate the connectedness of art to who we are and where we stand" (2010, p. 57).

> "Art's epistemic character resides in its ability to *offer the very reflection on who we are, on where we stand,* that is obscured from sight by the discursive and conceptual procedures of scientific rationality." (p. 50, my emphasis)

[2] These themes would also surface throughout this PhD research, at the edges...

The first of these questions, then, is addressed through practice, by the production of the data image *Untitled_Force*. Created through the performative lab practice of the Atomic Force Microscope, a research practice of the real world, in which data 'meets' the biological, through touch in an intimate relation (as I established in Chapter 2). The AFM is a measuring instrument enmeshed in "the discursive and conceptual procedures of scientific rationality" (p. 50). To work with the AFM technology as part of a *poetic* approach brings about ways to destabilise the empiricism of the material, whilst reflecting "on where we stand" (p. 50).

The two questions that I will focus on in Part Two, therefore, are:

- at what points does the digital become material?
- what happens in this space: the surface tension between the digital and the material?

As I will reveal and articulate in this next section, through my methodology I bring together an intuitive approach to making (a tacit crystallisation process) and the techno-scientific engineering lab practice of Additive Layer Manufacture. Through artistic research – *poetic praxis* – *Untitled_Force* spans the threshold between the two.

Figure 18: Field Experiments: Reflecting satellites (April 2012) (Mirror, liquid surface) Photo: iPhone 4 Smartphone.

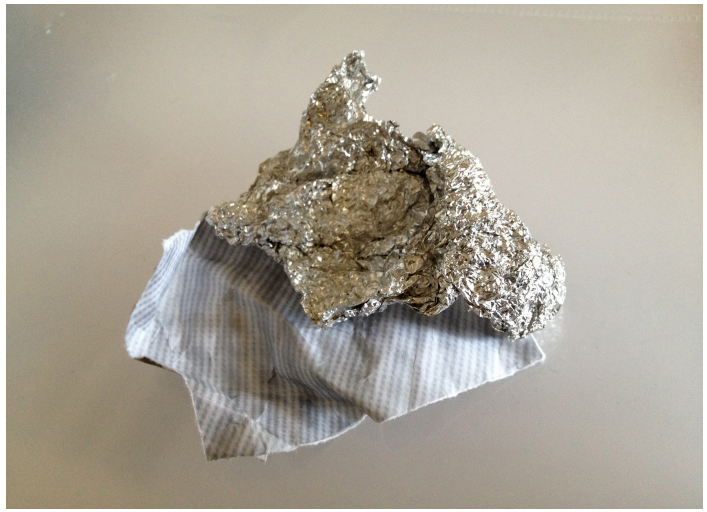


Figure 19: *We negotiate space in a tactile relation.* Studio experiments: Becoming material (March 2012) (Pure Flow print paper and aluminium foil, nylon surface) Photo: iPhone 4 Smartphone.

Methodology: "Conducting an original investigation in and through art objects and creative processes"

(Henk Borgdorff, 2010, p. 63)

My research process (as practice) went through two distinct stages: the first was a process of experimentation, working with different materials in order to explore, perhaps somewhat naïvely, an understanding of my research questions; this foregrounded the second stage, which was a lab-based practice of fabrication.

I documented time spent working in the studio through photographs of objects made, often with rudimentary materials, as sketches or outlines of an area keenly felt or sensed. These were guided by an intuitive approach as the ideas and experiences became more like sediment, and crystallised into forms:

> "Sedimentation as a process that takes place – a period of research, reflection, considering materials, and then suddenly (from behind) a need, recourse to make – to settle it onto some form – almost like a method of crystallisation – or sedimentation – to *align*." (Notebook, November 2012)

Images of some of these crystalline forms can be seen in Figures 18 and 19[3], and in the Portfolio of documentation (pp. 38-41). These processes were an important aspect of the methodology. Burnett clarifies: "the

[3] Making work in the studio – exploring how things / surfaces become three-dimensional, through playing with graph paper / mirrors. Engagements with materials.

materialisation of intuition has always been an important part of work in the arts and is central to teaching and learning the skills and competencies needed to create objects and experiences" (2008, p. 117). In these instances, documentation became an integral part of this process; I would document key instances where ideas, formulations and materials crystallised into an image.

Crystallisation

Much later, towards the end of the enquiry, I discovered that the figure of crystallisation appears in qualitative research "as the central imaginary" (Richardson, 2005, p. 963), articulating the multifaceted nature of an enquiry that draws on a multitude of approaches. Laurel Richardson writes that through this process, "crystals grow, change and are altered, but they are not amorphous" (Richardson and St. Pierre, 2005, p. 963). Here, in my artistic research, crystallisation occurred both within and through practice, as ideas and sensations *became* form. Artistic objects (artworks) arise through this process, out of an experiential and embodied practice that evolves and takes time, and in this way, are not simply *illustrations* of favoured concepts.

Through exhibition and discussion the artworks also became performative, becoming "prisms that reflect externalities and refract within themselves. […] what we see depends on our angle of response" (Richardson and St. Pierre, 2005, p. 963). This last point will be demonstrated in Chapter 8, in which I discuss peer critique and feedback on the artworks as embodiments of the research.

Invited discussion and exhibition

My studio-based research activity was supplemented by critiques and discussions about the work by invited artists and curators.[4] Spike Open Studios offered annual occasions for informal interaction and conversations to take place with artists and members of the public. Presenting the work to a public was a fundamental aspect of the methodology, as a means of testing how and where to site the work, in different contexts. In these instances I could consider how the work would convey the themes of the research to audiences, both within and without the academic field.

In a contemporary context, my studio research time also included the screen of the laptop or smartphone. In addition to featuring as a subject of the research, then, portable, wireless technologies became embedded in the methodology, capturing experiments with Google Maps (Figures 2-5); framing articulations of ideas, materials and things 'to hand'; alongside recording supervision sessions, interviews and critique.

During the course of study, I also undertook two residencies alongside the PhD: the first in Glenn Nevis, Scotland (*Outlandia* 2013) and the second around the archipelago of Svalbard (*The Arctic Circle* 2015). As remote residencies, they both offered unique encounters with *Open Spaces* (Sayre 1989) or *Wild Places* (MacFarlane 2007), and also

[4] These visits included curators Ros Carter (John Hansard Gallery), Carolyn Black and Matt Burrows (Exeter Phoenix); and artists Michael Stumpf., Melanie Jackson, Karen di Franco and Maia Conran.

Figure 20: Outlandia: reflecting satellites (June 2013)

Figure 21: Outlandia: reflecting satellites (June 2013)

opportunities to reflect on the research from acute positions of distance. It is not easy to codify these experiences, although they are implicitly present in the research.

> "Research is more like exploration than like following a firm path […] unsystematic drifting, serendipity, chance inspirations and clues form an integral part. […] Methodologically speaking the creative process forms the pathway." (Borgdorff, 2010, p. 57, re-ordered).

Within this landscape, my studio became a crucially important site, especially as a physical space in which to ground the artistic research (Portfolio p. 43).

Fabrication

Nathan Brown defines fabrication as "the field in which techno-science and poetry come together under the sign of building, as branches of *materials research"* (2004, p. 178). In contemporary, post-industrial society, fabrication and the fabrics or materials used (carbon fibre, silicone and graphene, for example [5]) are closely entangled with high-end technologies. Fabrication within this research enquiry also denotes those practices which are collaborative, out-sourced or machined, alongside the intuitive material explorations undertaken alone in the studio. Fabrication in this project occurs largely through print media, from giclée, to large-scale billboard, risograph and including 3D ALM (Additive Layer Manufacturing). In this process fabrication speaks of sophisticated lab practices where lasers sinter layer upon tiny layer of powdered nylon.

Fabrication also acknowledges a power dynamic between commissioner and maker. To 'have something fabricated' usually denotes someone else realising the work to your specifications or design. As such, the term also permits us to think of the author and the artist in an expanded role: "the human is not necessarily the centre of everything the way it was in much earlier eras. We now have all these wonderful machines that we're interacting with and increasingly dependent on" (Hayles, 2009).

[5] In the early exploratory stages of the research I took part in a materials / making workshop led by fabricators Plenderleith & Scantlebury, where I had the opportunity to experiment with fabrics including carbon fibre, silicon moulds and casting techniques (May 2012).

The role of the artist practitioner in a digital context, then, is one "engaged in a very complex system of distributed cognition":

> "if you create a digital work, you're collaborating with the software you're using to create that work, so the people who created the software are in a sense your *remote* collaborators. You're also collaborating with the computer hardware, and all of these have constraints and possibilities that you can explore." (Hayles, 2009)

During this research enquiry I collaborated with artists, technicians and engineers whose skillsets have been vital to the project and whose work in labs has enabled me to gain access to materials or processes. They include James Bradbury, Research Fellow at The Centre for Additive Layer Manufacturing (CALM) at Exeter University, and Genhua Pan, Professor of Spintronics and Nanomagnetism at the University of Plymouth, as well as the hundreds of *remote collaborators* who created the software, and the computer hardware.

Technologies also have a context, and in order to work within these contexts meant that I also had to work in a laboratory – a realm of institutional access that was facilitated through grants and a residency.[6] Lab practices require ritualised behaviours, specialist lab coats, large machines, industrial engineering processes, synthetic materials, lasers; as

[6] Exeter Phoenix Media Art commission paid for the first two objects to be fabricated at CALM up to a total cost of £600. This was followed by my successful applications to the BU Santander Networking Grant for Postgraduate Researchers (Total £3500) See Appendix 8.

well as the more implicit, immaterial resources of waiting: patience and trust.

As a result of working in these different contexts, I did not directly handle the machines, so a kind of 'alienation from the making' also became part of the process. To work in this field meant that as a practitioner, I had contact through conversations and emails. I sometimes felt a lack of control in these processes, which were often hidden, opaque and involved long periods of silence. Working with things one doesn't necessarily understand in their entirety, often means having to observe rather than to make. At the same time, the practitioner is changed by the experience of producing the work; as Linden Reilly writes: "it changes the way they think, the way they feel, the way they are" (2002, p. 5). To gain further insight into this element of the practice, I initiated and documented a semi-structured interview with James Bradbury, Research Fellow at CALM, Exeter University. (See Appendix 6: *Interview with Mr. James Bradbury* for the full transcript.)

Reflections on process

With this research project I had limited access to the lab, due in part to the logistics of the process; as the prints could take between 9 and 24 hours to build, many were fabricated through the night or over a weekend when access was prohibited. Due to the Centre's position within the University, there were also projects being developed as industrial prototypes for clients including the MoD; work that was highly confidential, so again, access was limited.

A malfunction could significantly impede the machine's and the lab's workload, so considerations such as the financial value of the machine, cost of materials and process of manufacture were paramount. If the machine had not been able to fabricate one of the works in its entirety (due to the problems with the data file or build) then the machine would be stopped and any resulting plastic cleared immediately. In retrospect, it may have been interesting to see the results of these errors (asking for a photograph for example), but high demands were already being placed on the staff working in the lab.

There were moments when I felt removed from the print fabrication, and at times I could not get as close to the process as I would have liked to. This made it difficult to always 'see' exactly what was happening. Waiting for the news and photographs of the next print being made could feel frustrating. These were followed by points of surprise when I'd receive an email with a photo attached from the lab, and I'd be astonished by the outcome.

At times it felt as if I were waiting for a blood test result. There was an interesting similarity in the consultation process, where I was meeting with an expert in order to seek advice, looking at a screen for features of virtual objects and CAD scans, in a similar way to looking at medical Ultrasound. There was a definite sense of being in the lab – peering into the large white machine in which things were developing; growing – like an incubator where microorganisms develop under controlled conditions.

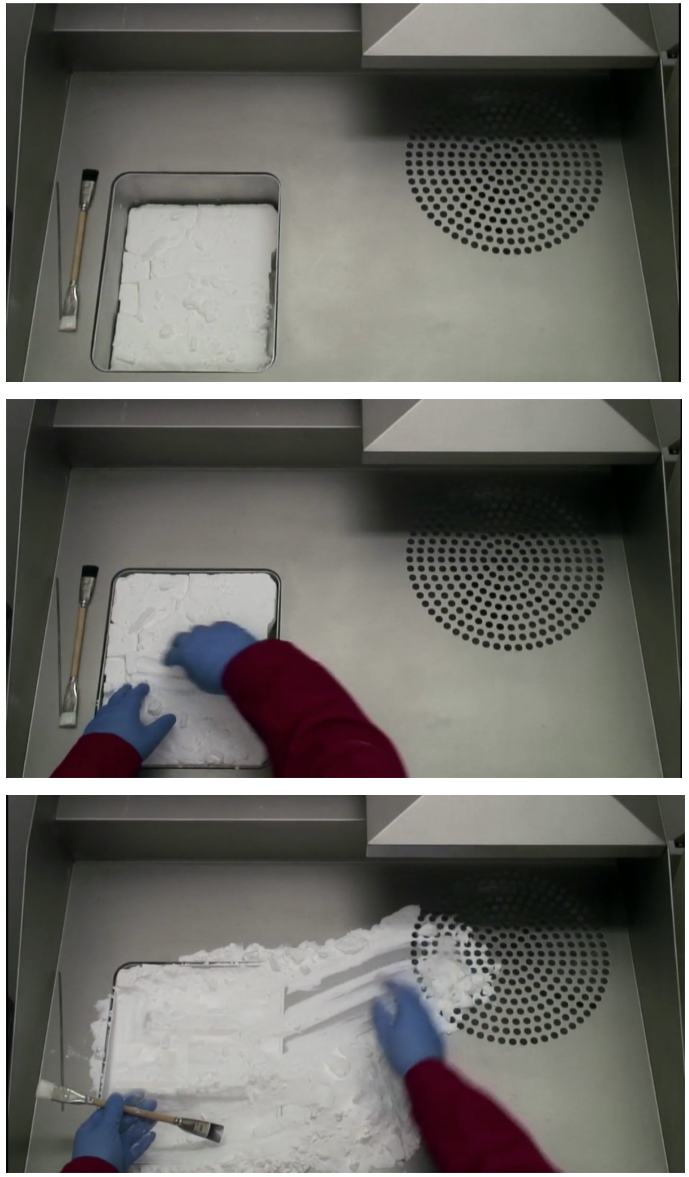


Figure 22: Uncovering the printed object (CALM)
Still images from *In Praise of Scribes* Zoe Tissandier (2013)

However, there was always a sense of feeling the work grow and develop, which was a fundamental part of the project. As Linden Reilly writes:

> "The thing emerges within what is present, both physically and in an immanent sense. The work does not merely emerge in the world, it simultaneously emerges in the practitioner who may see that which has been dimly felt as the work, may see clearly what they have been feeling, only at that point where it "feels right", only as it emerges as a physical form." (2002, p. 5)

Translating, from the "dream of information"

(Hayles, 2005, p. 62)

A significant stage during the research methodology was when I decided to render *Untitled_Force* from a digital object into a printed form (from the "dream of information"). As Sean Cubitt reminds us, "Digital objects have neither mass nor solidity" (2014, p. 232) yet they retain an elusive materiality.

This is a difficult area and my key area of enquiry. With this research project, I consider through the methodology of artistic research, how (in what ways) or at what points, the digital becomes material. Also, what happens in this space: the surface tension between the digital and the material?

An integral aspect of my project, then, has been an acknowledgement that this is an area of difficulty; there is a surface tension here between the digital and material that connotes strain or unease. This is a contested arena, full of cross-disciplinary complexities. Through my artistic research methodology, the works – the concrete objects or outcomes – of the artistic research, function as a site where these difficulties come into play; they are instantiated as form. Thus, they operate as sites for questioning; they raise the question of where these two axes of digital / material might meet, in a threshold occasion.

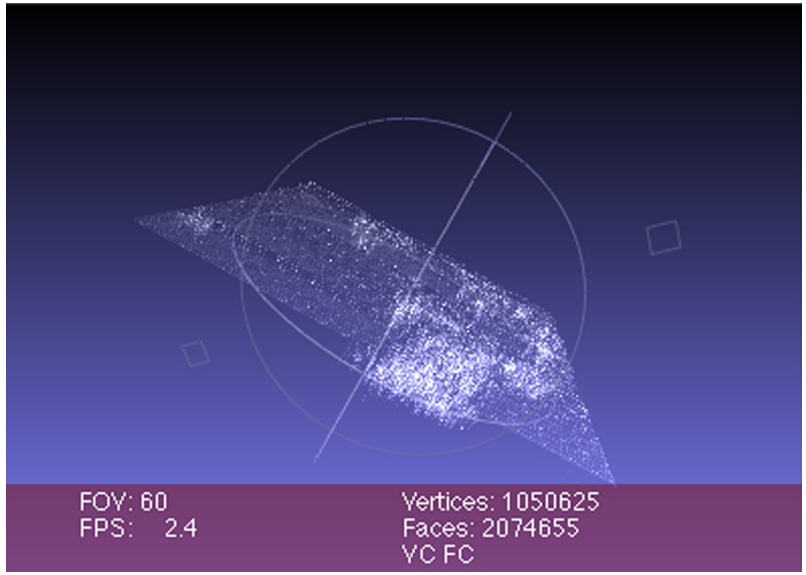


Figure 23: *Untitled_Force* in *MeshLab* Software (2012). Screenshot

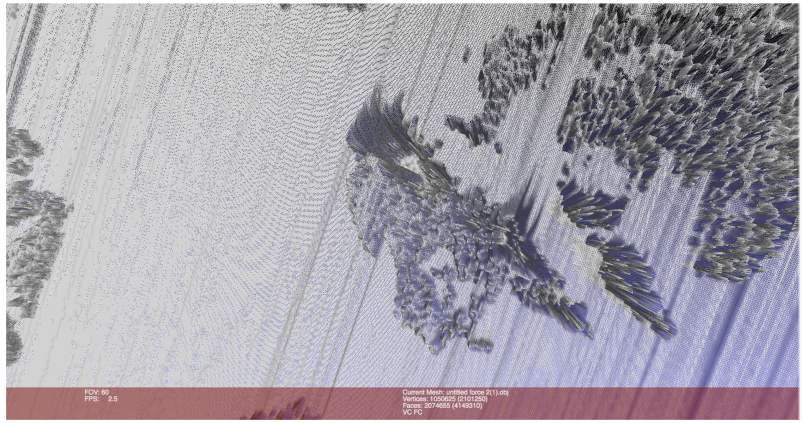


Figure 24: *Untitled_Force* in *MeshLab* Software (2012). Screenshot

Thus the works themselves also function as material documents; they visualise and concretise the creative processes of the artistic research, in attempting to make the digital physical; material. The excitement of the research, therefore, was in seeing what happened when inconsistencies or frictions were forced to meet each other in this threshold space.

Virtual model as volumatic landscape

In the preceding Chapter, I considered the AFM data *Untitled_Force* as a two-dimensional image. By placing the work alongside images of *remote-sensing* – satellite vistas over distant terrain – I re-contextualised the data, alluding to metaphors of technologised interior landscapes.

Opening *Untitled_Force* as an obj.file (object file) in 3D virtual modelling software – *Blender* (2012) or *MeshLab* (2012)[7] – also revealed an unexpected and distinctly unsettling topography. I could now see this *performative* moment: this encounter (between the Atomic Force Microscope and the blood) as a data-mesh; a semi-transparent surface, which visually echoes LiDAR or satellite schematics of strange geological features.[8]

[7] Both Open Source.

[8] LiDAR is a remote sensing technology, that can measure the distance to, or other properties of, targets by illuminating the target with laser light and analysing the backscattered light. (Wikipedia)

Interestingly, the AFM also reads the surface of the sample using a laser, "A laser light reflected from the back of the cantilever measures the deflection of the cantilever. This information is fed back to a computer, which generates a map of topography and/or other properties of interest." (Appendix 3)

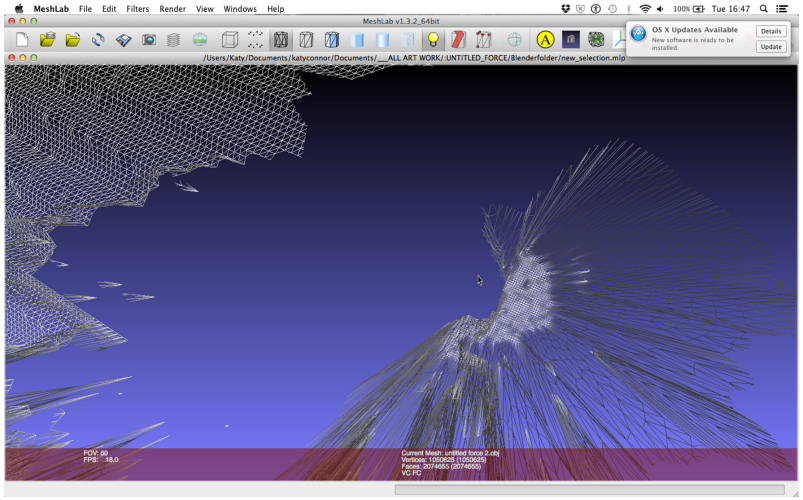


Figure 25: *Untitled_Force* in *MeshLab* Software (2012). Screenshot

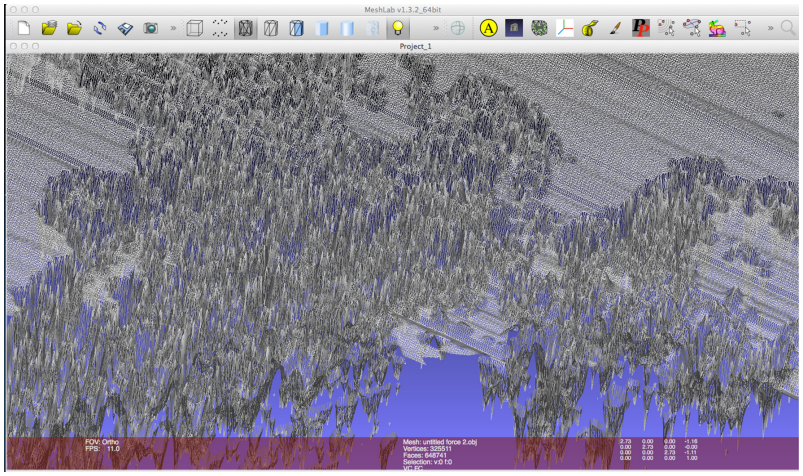


Figure 26: *Untitled_Force* in *MeshLab* Software (2012). Screenshot

This was an uneasy topography of surface and depth spines: peaks and valleys that reached both high above and deep beneath the assumed 'sea level' of the image. As I struggled to translate these back into the sensible, as natural mimetic structures, I thought of glaciers: icebergs, both below and above the sea-like surface; or the interior of a cave, resplendent with both stalactites and stalagmites.

Whilst the software struggled with the data, I struggled to comprehend how such an overwhelming complexity (of form), could be created at such a tiny scale. The size of the sample at 0.05 mm was less than the thickness of an A4 sheet of paper. Yet as a three-dimensional model in the virtual space of *MeshLab*, *Untitled_Force* had 2,074,655 individual facets.[9] Inside the computer, this new work seemed to exist in a prospective, virtual space – a space of potential. Having no relative scale it existed purely in suspension. The folds, ripples and waves in its surface gave it a frozen quality, as a landscape of extremes.[10] Looking at the model in the space of the screen was also frustrating; I wanted to get closer to the surface of the scan, but as I touched it with the cursor, the scan itself splintered and disappeared. The closer I tried to get to the surface, the more the image fractured and separated, cracking into separate splinters of fabric and then vanishing completely (Figure 25).

[9] We can start to comprehend this resolution by comparing this a domestic flat-bed scanner, which scans at 600 dpi.

[10] These forms reminded me of Herbert Ponting's first photographs of the ice forms off the coast of Antarctica, Lynda Benglis' dripped sculptural forms in wax, and the 'mimoids' Lem articulates in *Solaris.*

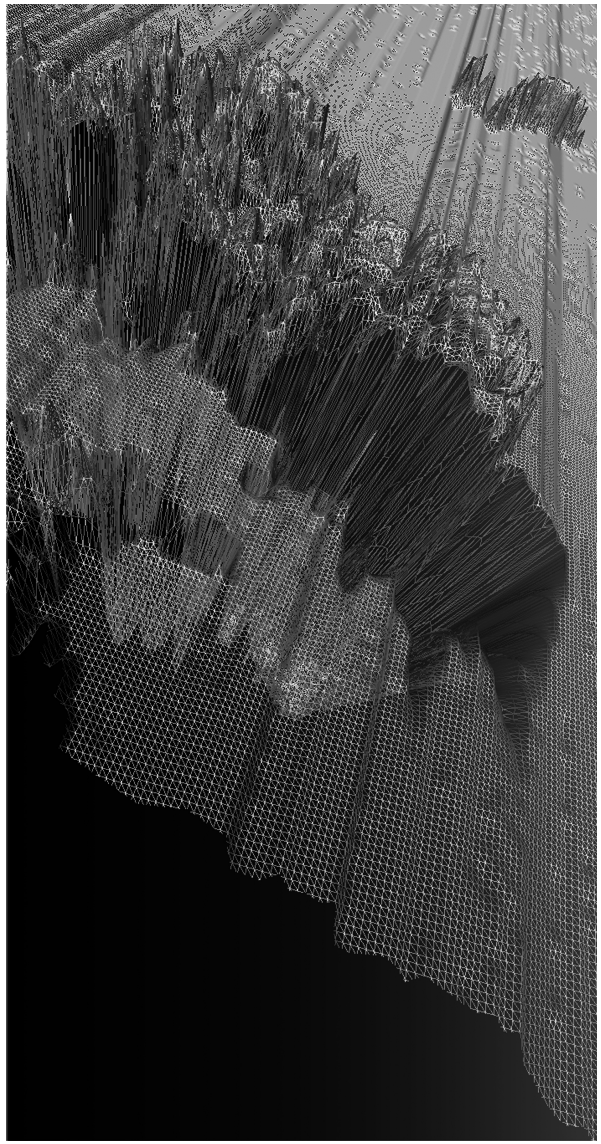


Figure 27: Screenshot of data in *MeshLab:* desaturated with removal of text (2013)

Whilst this semi-transparent structure can be rendered as a solid through the application of light and shadow, I chose to retain the wireframe view, so that the structure was *barely there*. I preferred this way of perceiving the model as both a surface and an outline; as a pattern of simple polygons; a tessellation of triangles: Δ. I could look through and glide over it, as an uncanny landscape of possibility. In doing so I wondered how it would be to navigate such terrain; to fly over its surface.

The ripple of scan data is a surface of over 2 million triangular facets within its tiny surface area of 0.05 mm.[2] The critical performance of scanning has produced such a fine detailed topography, it is no longer recognisable as blood. Through measuring the blood, the AFM technology models it as a digital object within a virtual space; an abstract form suspended in a void, like an idea or concept, or a "dream of information" (Hayles).

As a means to comprehend the relationship between the data and the images, the surface and the screen, I started to capture screenshots, each providing a different view onto and into this landscape. I desaturated the purple backdrops into black and white[11]; splintered forms of data

[11] I'd taken this approach to reworking technologies in previous works; with medical Ultrasound in *Aureole* (2005) and *Afterglow* (2007). When I rework this material, I'm removing any text or graphic that associates it with any particular diagnostic function or *instrumental* association; moving from *techné* to *poesis*.

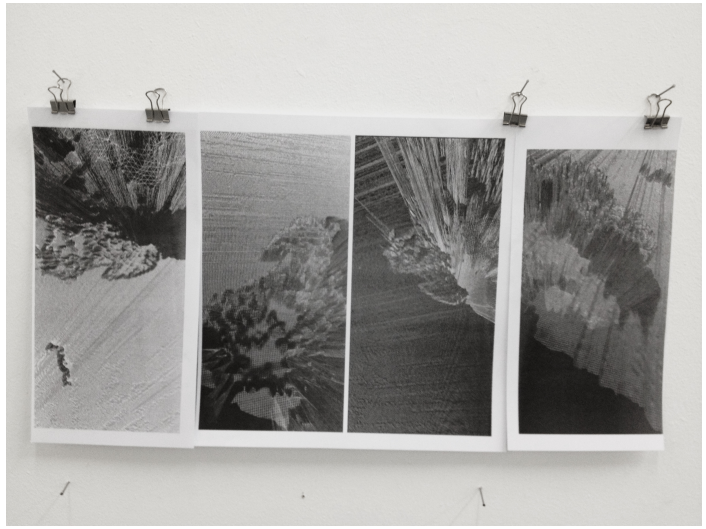


Figure 28: Risographs in studio (2013) dimensions 13 cm x 26 cm each

Figure 29: First test prints in Studio (2014) 130 cm x 260 cm each

becoming intricate matrices suspended in a dark void-space.[12] Printing them out as photographs, they became residual forms that lingered long after the software had been shut down and the laptop lid closed.

With the help of a printmaker,[13] I then risographed a selection of these screenshots (see Figure 28) and re-scanned the prints with a flat-bed scanner, so that they once again became digital surfaces. Using Photoshop software I extended and elongated these surfaces, printing them out on longer and larger sheets of paper; from small risographs (Figure 28) to large-scale prints measuring 130 cm wide and 260 cm high (Figure 29), and then to 300 cm high by 1200 cm wide (Figure 30). The works became material, concrete, through a crystallisation of form.

I also captured animated video loops that hover over these splinters, catching these matrices in suspension (See Portfolio p. 13 and pp. 22-26).

[12] This reminded me of the void-space surrounding the track in *Ghost Valley* from the video game *Super Mario Kart* (Nintendo 1992).

[13] Jono Lewarne: City Edition Studio.

Figure 30: Billboard print (detail) Test Space Spike Island (2016) dimensions 600 cm x 300 cm

"The practitioner may go through successive stages of planning, acting, reflecting, revising the plan, then acting again. They may move near to take a close look, or take some steps back to see what it looks like from a distance […] An intense experience, a relationship with a thing that […] emerges through doing, through the interrelationship of materials, that which the practitioner brings to the practice, and the context." (Linden Reilly, 2002, p. 5)

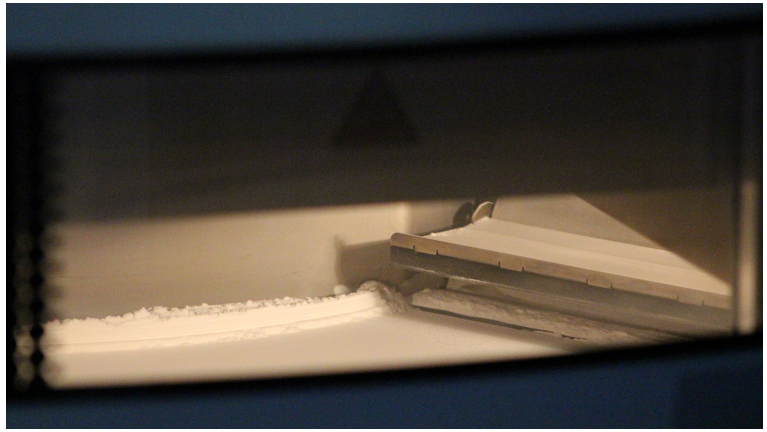


Figure 31: Standing, looking into the machine (2013)
Documentation during the process of laser sintering *Fragment No. 4*

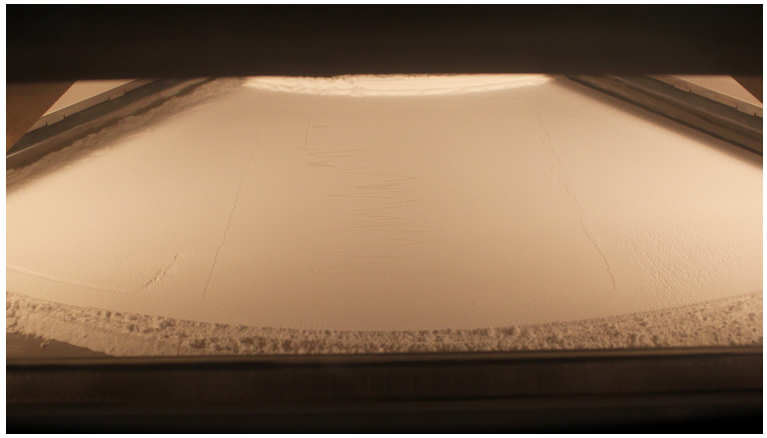


Figure 32: Standing, looking into the machine (2013)
Documentation during the process of laser sintering *Fragment No. 4*

"The practitioner "stands over" that which is being generated through their practice ... both physically and metaphorically."

(Linden Reilly, *An alternative model of 'knowledge' for the arts,* 2002, p. 5)

Documentation

The video documentation here functions as a means of coming to understand how the works were made. Like the large-scale prints, documentation then becomes (another means of making) the work; as residual forms they *remain* after the act of making.

Capturing the process – documenting the build over time, through video – enabled me to spend a whole day in the lab; to stand and observe the physical process of fabrication, and to feel what was being generated through the practice. Standing beside this machine, which at two metres was much taller and wider than me, enabled me to peer in through its narrow horizontal window, to witness *its* interior landscape.

> "To stand over or near, is to take your body and its sensory receptors close to something, to maximise information gathered […] an act of deliberation; standing still, not walking or running, but standing, as if all the body's energy were given to perceiving and thinking. Standing because perception and cognition take time; time to gather the information, and to work it through." (Reilly, 2002, p. 4)

This time spent in the lab facilitated my perception of the process: how the laser sintered each miniscule layer of the form, the arm of the printer

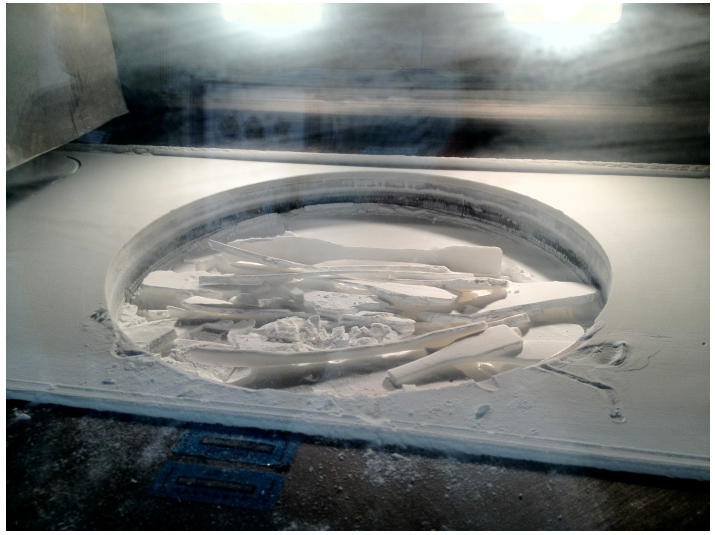


Figure 33: One of the ALM machines at CALM (2012)
Photo: iPhone 4 Smartphone.

Figure 34: Caspar David Friedrich *The Sea of Ice* (1824)
Oil on Canvas 96.7cm x 126.9 cm. Kunsthalle Hamburg.

sweeping back and forth; the powder base reset; the crack of the pack ice; the machine sound. All of this gave a real sense of the material process of fabrication and a real measure of the time taken to physically build these objects, layer by layer by layer.[14] Where the large paper prints articulate a shift in scale – a feeling of being dwarfed by the virtual object – a few hours standing overlooking this miniature landscape also became unsettling: I felt gargantuan. In a reversal of perspective, the small window of the machine revealed a landscape simultaneously tiny and vast. The interior of the machine now assumed the dimensions of an Arctic tundra, continually swept and re-swept by a machinic snow plough. I was both suspended in deep geological time and yet somehow, witnessing the future.

> "At the limits of fabrication, poetry and technoscience operate at the horizon of the visible and beyond, in those *impossible* and *illegible* spaces from which we are approached by bodies and words, and wherein text passes over into texture." (Brown, 2004, p. 178)

[14] See video documentation (Portfolio p. 12). This video document was also installed on a TV monitor at the Control Room, Bristol (January 2016).

Chapter 5
Fabrication in the Lab: A Pragmatics of Resolve

Untitled_Force as a series of three-dimensional synthetic objects

Between 2012 and 2014, I fabricated six objects at the Centre for Additive Layer Manufacture (CALM) at Exeter University, in the College of Engineering, Mathematics and Physical Sciences. The process took two years in total, and there were two phases of production: the first from June 2012 to October 2012, and the second from February 2013 to June 2014.[1] During that time I worked with a number of staff, but predominantly with James Bradbury, CALM Coordinator and Research Fellow. Communication between James and I was maintained throughout through a series of face-to-face meetings, consultations, emails and telephone conversations.[2]

At the start of the project I had an introduction to CALM (June 2012) and the processes, materials and examples of Additive Layer

[1] The first phase was supported through the Exeter Phoenix Media Arts Bursary (2012). This award funded the production of the first two prints, with a public exhibition *NeoReplicants* at Exeter Phoenix, from November 2012 – January 2013.

The second phase was financially supported through my application to the Santander BU PGR Bursary (see Appendix 8). This grant enabled the production of the final four prints (£3500). Having the financial means to pay the University to produce the work gave me a great deal more artistic freedom with the project.

[2] Appendix 9: email correspondence with CALM (2012 –2014).

Manufacturing (ALM), followed by a tour of the lab. I then made five further visits to the CALM fabrication lab during the production process, (in October 2012, February, May and June 2013 and February 2014). In June 2013 I also documented one of the objects (*Fragment number 4*) being sintered. The fabrication process took a long time, each object taking around nine hours to build. There were many difficulties.

Intention

My original intention for *Untitled_Force* as a work was to fabricate the whole of the Atomic Force Microscope scan into a three-dimensional model, through the process of Additive Layer Manufacturing (ALM). On reflection I can see that this intention came from a rather naïve understanding of the digital and material processes involved, but I had assumed it was achievable, having read some of the surrounding literature about 3D Print processes. However, several immediate concerns prevented this. In taking the 3D data file from the scan and fabricating it into a three-dimensional object, two main issues arose. Firstly, the AFM scan had no 'thickness', meaning that the form of the scan was equivalent to a wire frame or a mesh, with no actual depth – just surface. Secondly, whilst the scan itself was incredibly detailed, it was absolutely minute in size. The material scanned by the AFM was 0.05 mm^2 yet the object file size was enormous. These two issues combined to create a number of problems for the 3D fabrication process, in the software, the hardware, and in the physical material process of building the three-dimensional model.

Technical specification

All of the objects were fabricated within an EOS Formiga P100 (2006).[3] This is a Selective Laser Sintering system, in which a thermoplastic powder is fused together by a fine laser beam. The plastic used (PA 2200) was a fine, polyamide powder, which is biocompatible, and could withstand a high mechanical and thermal load. The fine diameter (spot size) of the laser enables wall thicknesses of 0.4 mm to be created.

The Formiga is a self supporting system; it has a compact bed of powder which supports the object geometry being built within it, so there is a degree of flexibility with the designs and structures being built. (Other systems need scaffolding to support the structure, or a base plate to build on to, for example.) Once the piece had been sintered, it then needed to be unpacked from the bed of powder, and cleaned using compressed air to remove the excess nylon dust (See Figure 22).

Due to the incredible detail of the original AFM scan file, the process of translation into a 3D object became problematic. The computers' processing power struggled with handling the vast amounts of data; the laser, whilst attempting to build further parts, melted the detail of the spikes in the model itself. The limits of the technology's capacities to build were reached in the quest for instrumental use. The edges of its capabilities exposed. In the following section I shall outline the fabrication process of these six separate prints.

[3] EOS (Electro Optical Systems) were founded in 1989, Munich, Germany. See http://www.eos.info

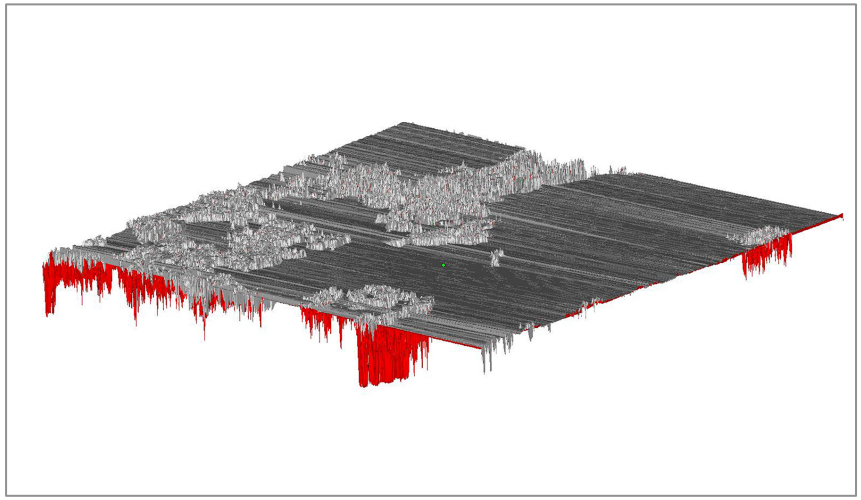


Figure 35: First image from CALM, via email, 13 July 2012
This was the first proposed model, "but the detail is too fine" James Bradbury, via email (Appendix 9) Image: CALM (2012)

Phase One: Problem solving

From June to November 2012, the pragmatics of how to initially produce the work as three-dimensional objects was established, and the first two objects were produced. This process took around five months.

The first task was to create a 'thickness' for the scan (at a minimum depth of 1mm), which enabled the scan data to be built as an object. This thickness had to be created by the engineers *in the software*, to enable the object to be built virtually in three dimensions. The virtual object was then sliced into 'slice-data' for the machine to build. The challenge at this point was to allow for the detail to remain, and not to compromise the delicate form of the virtual model.

Secondly, scaling up the miniature scan within the software involved a great deal of processing power. This meant that building the virtual object was difficult, as the software often crashed (due to the phenomenal increase in file size).

Thirdly, translating the scan into an object that could be fabricated *physically* by the machine also proved to be a problem. The Formiga's build canister measures 180 x 200 x 250 mm, thus limiting any model to these dimensions. The largest size the scan could therefore be fabricated was 200 x 200 mm^2. [4]

[4] (As the original scan was 0.05 mm^2, this is a magnification of x4000.)

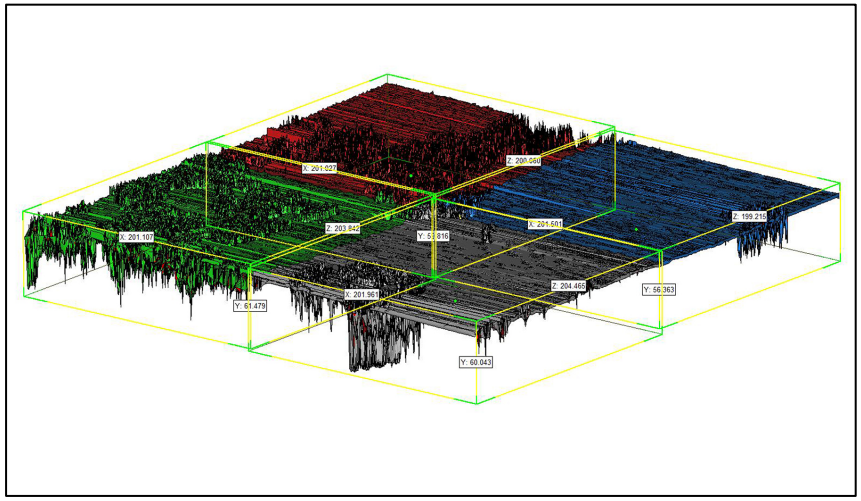


Figure 36: Second image from CALM, via email 18 July 2012 (Appendix 9)
Image: CALM (2012)

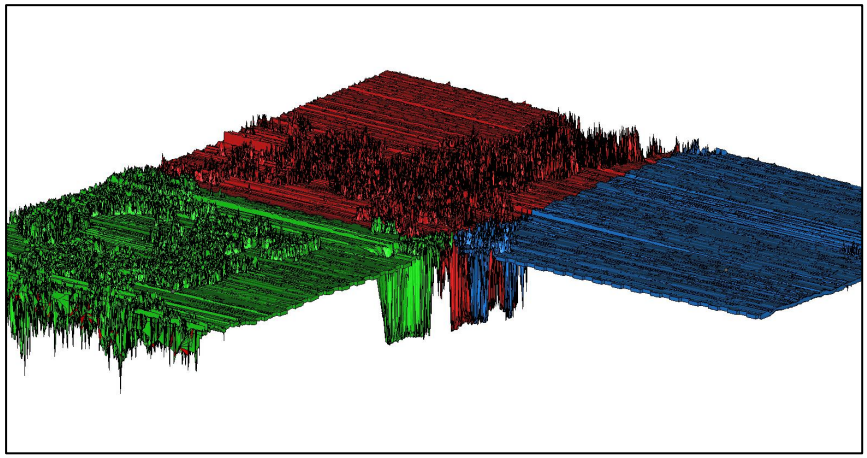


Figure 37: Second proposed model, CALM, via email 18 July 2012 (Appendix 9)
Image: CALM (2012)

A series of emails from the lab depicted how the scan data was being modelled in three dimensions. The first of these images (Fig. 35) documented the complete scan as one single model, which was immediately rejected, as "the detail is too fine" (James Bradbury, email 13 July 2012, Appendix 9). A second image arrived five days later, with a proposed model of the scan now separated into four distinct sections (Figure 36).

> "I have managed to give the scan a 2 mm thickness and keeping 95% of the detail on the spikes. I have also enlarged the piece to 400 mm^2 and separated it into four parts. This now can be built in four sections and jointed back together using plastic glue." (James Bradbury)

During this initial phase of building that followed there was an 11-week period of silence from the lab (18 July to 4 October 2012). Then, on 5 October 2012, I received the following email (with photographs, see Appendix 9) from James Bradbury:

> "I have some good and bad news for you. We have tried to make your part for you as requested, however as you can see by the photos, the detail on the spikes has been lost and the part warped and bent due to the thickness and shape. The whole team has been trying all week to come up with a solution to these problems, but as of yet we have not. […] We will of course continue to try and work this out to deliver your art to you as quickly as possible, but *as it stands you are the only artist who has managed to beat us when it comes to building a part.* I will contact you next week to update you on the situation." (James Bradbury, 2012, my emphasis)

Figure 38: Studio, detail of first attempt at print (2012)

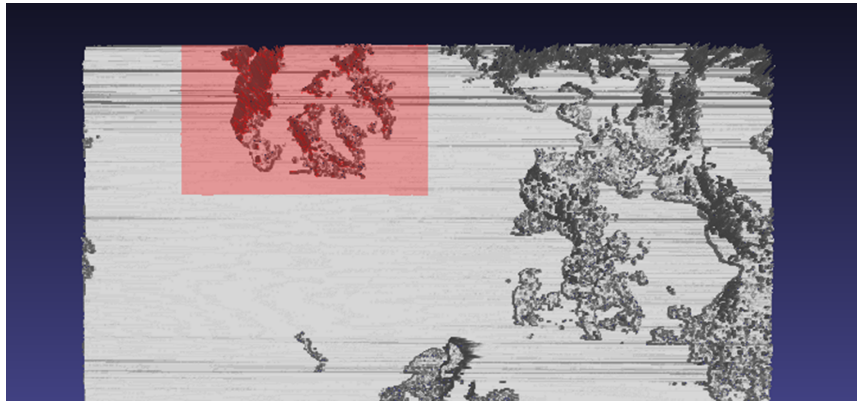


Figure 39: Selection to print in two halves (selected in *Meshlab* software) Screenshot (2012)

I realised at that point that it was simply not possible to fabricate the scan in its entirety. Even in four segments, it was apparent that the scale and the detail had demanded far too much of the machine; the polymer had melted.

On 16 October 2012, I had a meeting with CALM to consider the possibilities, where we discussed several options.[5] I then decided to select a small section of the scan geometry to be fabricated at a greater scale (see Figure 39). This would enable the machine to build some of the detail in the scan. Heading back to the studio, I received this email from James later the same day:

> "Once again thank you so much for making the effort to visit CALM to discuss your work and the current project. It was so useful in fact I believe I may very well have a solution (Maybe)!!
>
> I have been successful in creating section 1 (your first choice) data for an attempted build. Please find attached an image of the section with information.
>
> For your record: The wall thickness of the data ranges from 1 mm up to 3 mm. Unfortunately some fine detail (below 1 mm) has been lost, however, if successful I believe you will be happy with the outcome!

[5] This was the first build at the beginning of the project. I explained to James that these moments of difficulty were of great interest to an artist, and not necessarily 'failures'. And that silence was not good! James was very accommodating to the project, especially as it developed over time, and started to understand the process as an experimental mode of enquiry. This was the first instance when I became highly aware of the engineering paradigm as distinctly different from my own approach to making.

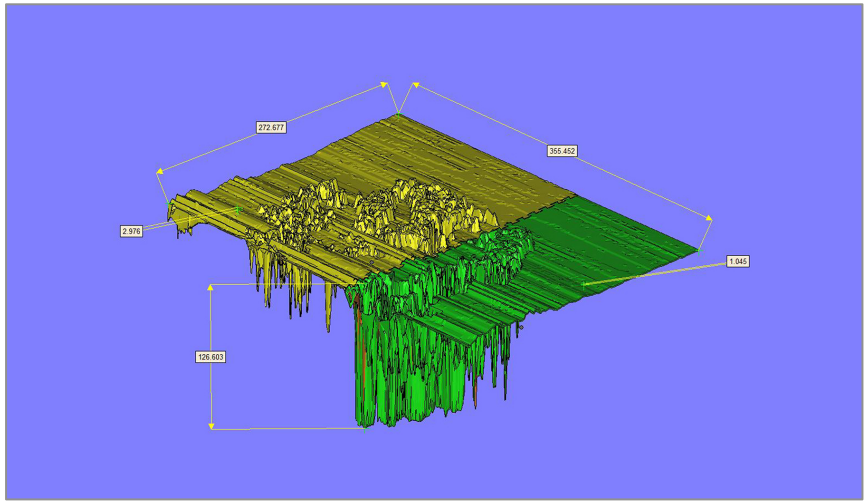


Figure 40: Proposed isolated section, sent via email, 16 October 2012 (Appendix 9) Image: CALM (2012)

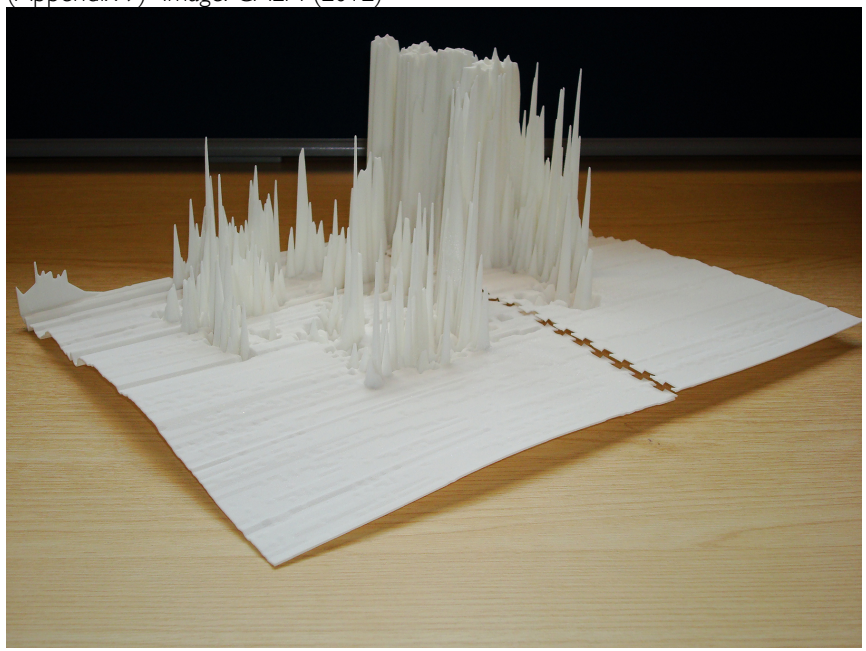


Figure 41: Photograph of first successful print, sent via email 19 October 2012 (Appendix 9) Image: CALM (2012)

> The section is approximately 270 mm x 355 mm total but is split in two parts. The largest spikes go up to 125mm long. This section will be made 455 times larger than the original size.
>
> The data has been refined enough so I have been able to process and slice ready for manufacture. Please can you let me know if you are happy with this?" (James Bradbury)

After sending my agreement, Sections 1 and 2 were successfully fabricated as three-dimensional objects three days later on 19 October 2012.[6]

[6] I selected one for the exhibition *NeoReplicants* (Nov 2012 – Jan 2013).

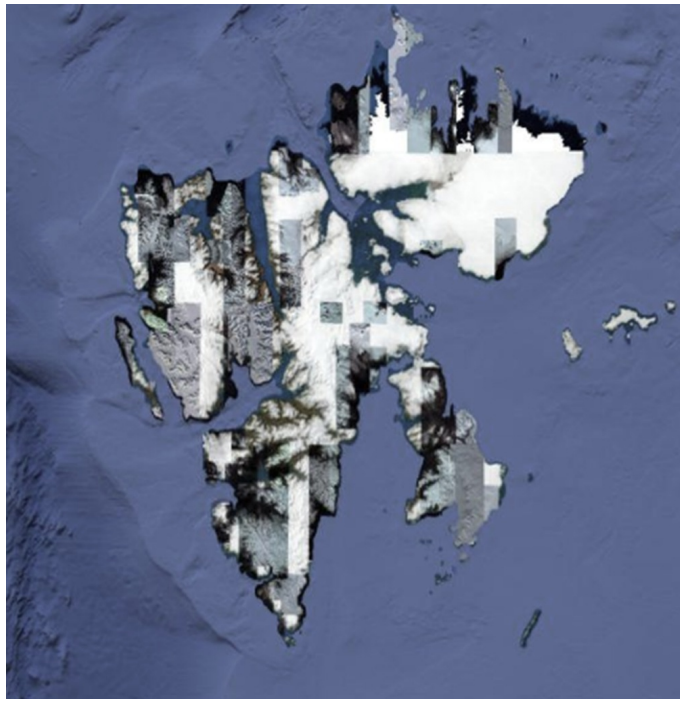


Figure 42: Google Maps satellite view over Svalbard
Screenshot from iPhone 4 Smartphone (2013)

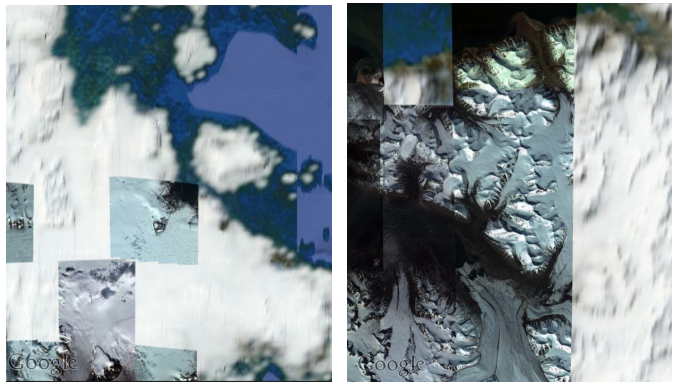


Figure 43: Google Maps satellite view over Svalbard (details)
Screenshots from iPhone 4 Smartphone (2013)

Poetic Praxis

This section will briefly describe how the data was selected, structured and rendered out, as "poetic debris" (La Frenais, p. 2). I consider the work here in its associative contexts; its relation to remote-sensing and satellite vistas; and the 'performative cartography' of the smartphone and Google Maps. Reflecting on how different spaces were mapped through the Google Maps software (Figures 42 and 43), I noted how the satellite imagery created different zones of intensity; where details become highly magnified in certain areas, yet blurred and indistinct in others. Some topographies appeared highly detailed, which gave an impression of creating a patchwork of intensity, with rough pixelated zones side by side, with sharp, glacial details across the flattened surface.

The virtual space of *MeshLab* is also modelled according to predetermined conventions. In *Digital Aesthetics* (1988) Sean Cubitt discusses how virtual, *machine vision* is rendered to correspond with traditional perspective, in an assumed monocular (one-eyed) culture. The digital software that renders the data visualizes it, making it decipherable and recognisable to the user, using the analogue of the map and the form of terrain to ensure familiarity. The force that has been measured at such a small scale is thus objectified in virtual space, as a topographic landscape. We use the same visual language of modelling space at the micro- and the macro-levels; from the nano-scale to the mountainous.

The image may resemble how a satellite perceives a distant landscape, but here I am reminded that this is how machines are programmed to model objects that they are "looking at", regardless of scale; whether above the earth in space,[7] or probing the force between molecules at the nano-scale. As systems of representation, they can be understood as "renditions of machine code in culturally specified forms":

> "The perspective of the single virtual eye/camera which gives access to virtual constructs in 2D and more surprisingly in 3D representations is entirely Cartesian […] To render mathematically generated digital imagery in these 'familiar' and 'user-friendly' versions […] demands that data be rendered in terms of visualities like the map and monocular perspective which are determinedly instrumental, and have to be applied to the data as a second layer of non-intrinsic regimes of looking." (pp. 34-35)[8]

We impose our (human) way of looking onto the machine. The object / force that is measured at such a small scale, in miniscule detail, is thus objectified in two and three dimensions as cartographic landscapes. The same visual language of modelling space (through cartography, through wire-frame) is used both at the nano-scale and at the scale of mountains (ie. through LiDAR).

So, my response to this 'instrumental' perspectival grid was to play with notions of scale and direction (orientation) that one might use to make use of a map. The fragments of the work – both as two-dimensional printed surfaces and three-dimensional sculptural objects – were all rendered at different scales, with different degrees of orientation. There is no singular map of the territory.[9]

Considering these visual anomalies in relation to my previous screenshots, studio and field experiments (Portfolio, pp. 38-41), Google Maps then became a framing device; a kind of stencil for selecting certain aspects of the virtual model in order to render sections of the data more fully, as *poetic* fragments. Thus *Untitled_Force* becomes analogous as a constructed image to satellite vistas of the Earth's surface; a distant view over a highly-individualised territory. "Spliced together by data processing, these are not ruined catastrophic surfaces but territories of a prolific encounter" (Chadwick, 1989, p. 97).

[7] Technics of satellite imaging – probing electromagnetic radiation.

[8] Hito Steyerl writes: "This space defined by linear perspective is calculable, navigable, and predictable. It allows the calculation of future risk, which can be anticipated, and therefore, managed. As a consequence, linear perspective not only transforms space, but also introduces the notion of a linear time, which allows mathematical prediction and, with it, linear progress. This is the second, temporal meaning of perspective: a view onto a calculable future" (Steyerl, 2011, p. 4).

[9] At this scale it is easy to lose sense of a relative size, scale or distance; undoing any pretence of similarity with scientific processes of map-making or cartography.

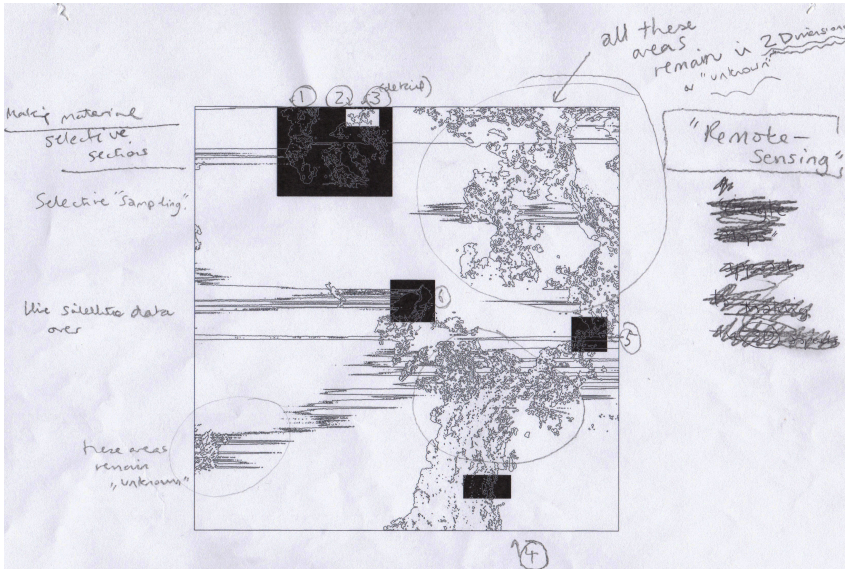


Figure 44: Sketchbook page showing sections of data (2013)

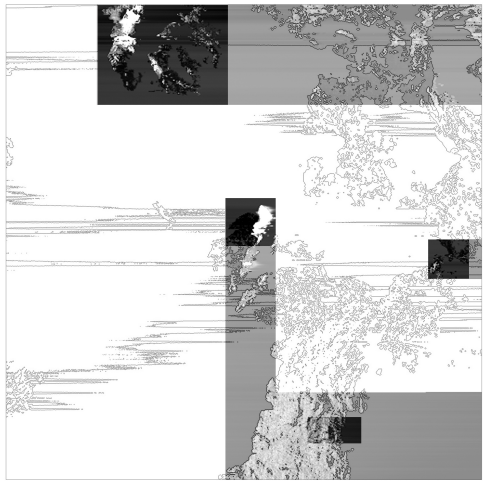


Figure 45: Notebook schematic (2014)

Phase Two: Four further fragments

Between February 2013 and June 2014, four further models were developed and fabricated at CALM. This second phase of production, over sixteen months, consisted of building a further four fragments of different sections of the scan data.[10] Treating the AFM 2D image as terrain, I considered isolating certain sections (an approach that mirrored this satellite patchwork) to be built at different scales.

Meeting on 26 February 2013 we discussed the limitations and possibilities of this next stage, taking sections of the scanned data and seeing how these could be fabricated, and finding at what scale the machine would be able to sinter the geometry. I explained that I was interested in more of an open-ended process, and was interested in what forms the machine would be able to fabricate and what its limitations would permit.

[10] This phase was funded through the BU PGR Santander Fund, at a total cost of £3500. I also made enquiries after my original intention (to build the full scan with much greater detail at a larger size), but with scale and detail being issues, as well as repeatability and viability, the financial cost to build the piece through the ALM process would have been prohibitive: "I have calculated the amount of sliced sections of the full scaled piece required to be built on the smallest and the biggest sized Laser Sintering Machines. 1) The largest system would be about 16 sections fitting into approximately 3-4 builds (A build equalling £5000 each). 2) The smallest system would be about 64 sections fitting into 25-30 builds (a build equalling £400 each). I hope this answers your question regarding making the piece full size" (Email from James Bradbury, February 2013. See Appendix 9).

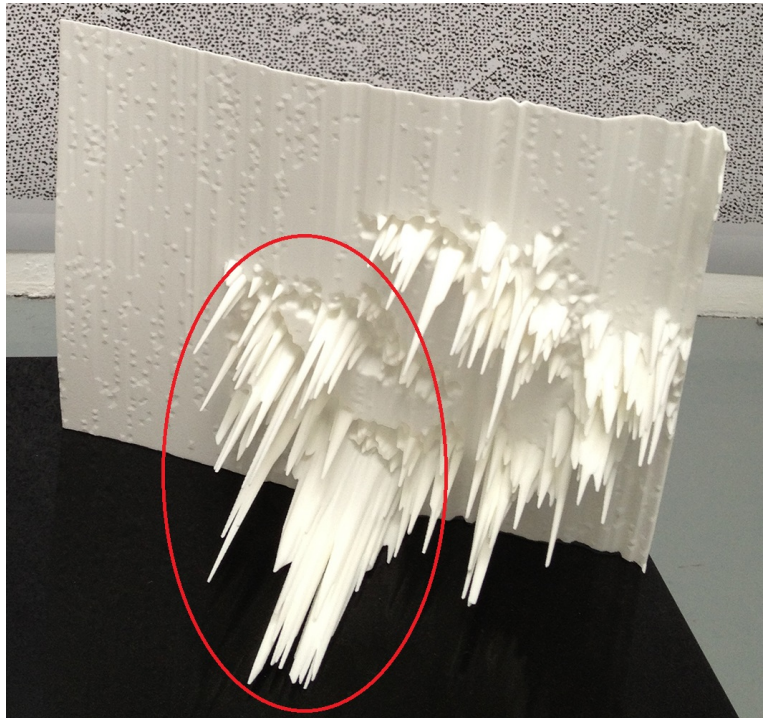


Figure 46: Section of *Fragment 2* highlighted to show area to be enlarged (2013)

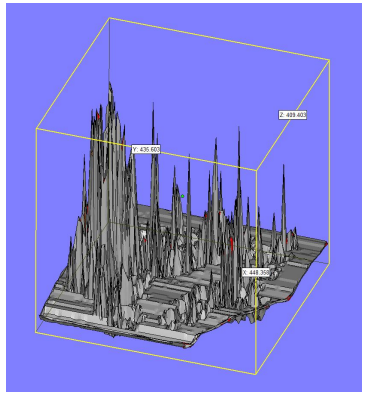


Figure 47: *Fragment 3*
This was rejected as I wanted to keep to a rectilinear shape
(Image: CALM 2013)

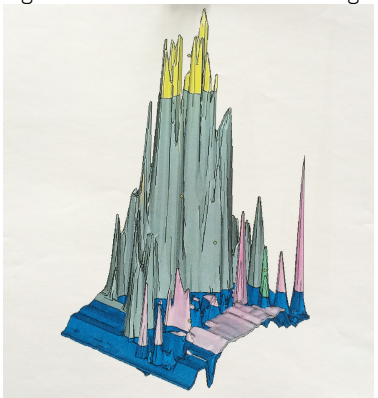


Figure 48: *Fragment 3*
The final, smaller section, enlarged to a greater scale
(Image: CALM 2013)

This meant that the production process took a longer time overall, as I wanted to see how each piece was realised before deciding on how the next section would be built. My only conditions for the prints were that they had to be square or rectangular sections, echoing the pixelated areas of Google Maps.

Fragment 3

Small section of *Fragment 2*, enlarged.

The first of these fragments was a small section of the first print, produced at a larger scale (Figure 46). I was interested to see how the same data could be rendered at a larger scale; what the resulting rendered figure would look like; and how it could be realised in the nylon material through the same process.

As previously, the ALM machinery struggled to build this in its entirety, and so the model had to be built in sections (Figure 47). James Bradley gave me an epoxy resin and some of the powdered nylon to reconstruct the work, although once in the studio, I decided to keep the distinct pieces (seen in Figure 48 as different coloured sections) separate.

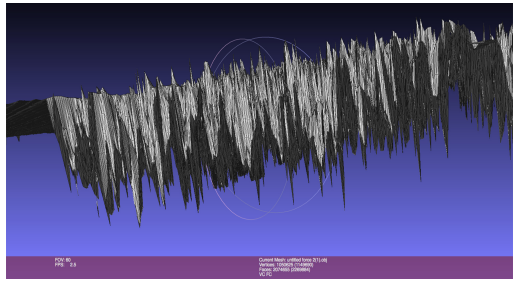


Figure 49: *Fragment 4,* Selected in *Meshlab.*. Screenshot (2013)

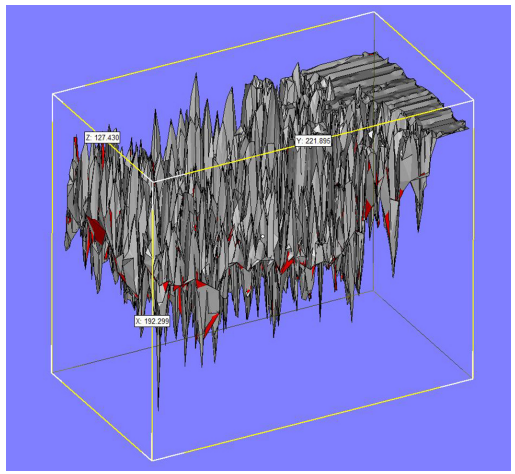


Figure 50: *Fragment 4,* Screenshot CALM (Appendix 9) (Image: CALM 2013)

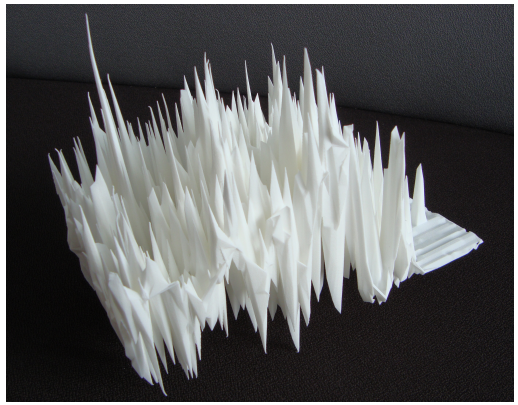


Figure 51: *Fragment 4* Completed 3D Print (Photo: CALM 2013)

Fragment 4

For this section I selected an area of much greater density. I was also able to gain access to the lab to capture the build through video documentation.

> "Please find attached an image from the new section we spoke about for the next stage of your project.
> The size of the section is 222 x 193 x 127mm (x,y,z).
> We can increase the height of the section if you so wish.
>
> I have managed to offset the spikes by 1mm to form the thickness, but I cannot thicken it up any more without losing some of the details (spikes).
>
> You can see on the image red triangles. [Figure 50.] These are "defects" in the geometry created from the original source file and subsequent operations.
> I have run a simulation on this section as it stands and it initially looks to be ok, however I would category this as "high risk".
>
> *What I am trying to say is I do not know if the section will form. Only by building it will we see if this is possible.*"
>
> (email correspondence with James Bradbury, May 2013, my emphasis; see Appendix 9)

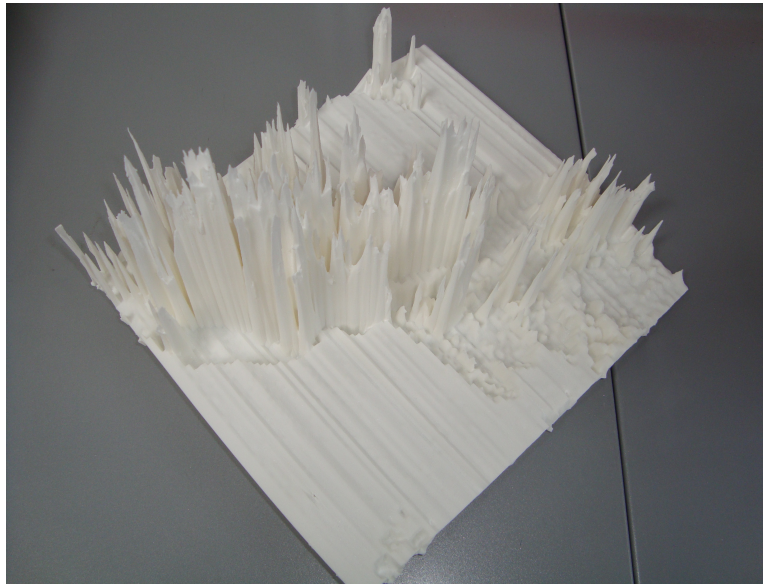


Figure 52: *Fragment 5* Completed 3D Print (Photo: CALM 2014)

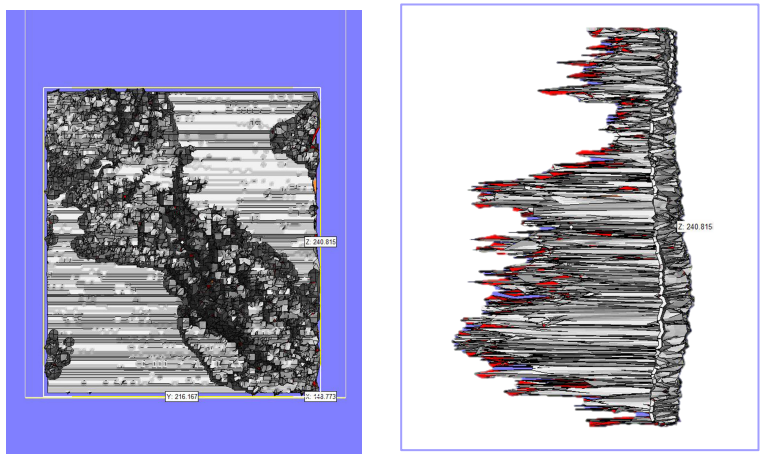


Figure 53: *Fragment 5* Proposed build, Screenshots CALM (Appendix 9) (Images: CALM 2014)

These final two sections were both realised at much larger magnifications, due to the smaller areas selected of the scan data.

Fragment 5

This penultimate section was taken from the far left of the scan data, and has an incredibly rough texture.

> "From our project meeting a couple of weeks ago, please find attached a few images of the section you identified you would like building next.
>
> I have also increased the overall size of the new section to be approximately 150mm x 220mm x 240mm."
>
> (email correspondence with James Bradbury, January 2014, Appendix 9)

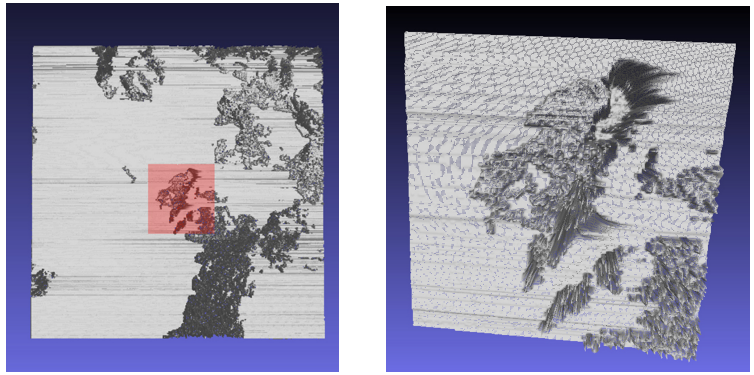


Figure 54: *Fragment 6* Central area selected in *Meshlab* software (2014)

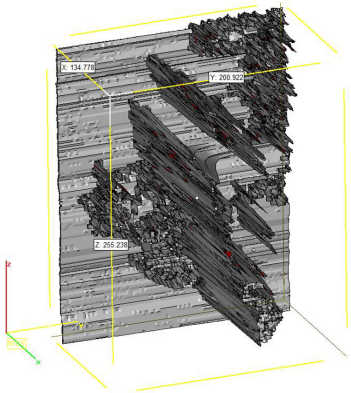


Figure 55: *Fragment 6* model (Screenshot: CALM 2014)

Figure 56: *Fragment 6* completed 3D Print (Photo: CALM 2014) (Appendix 9)

Fragment 6

This final fragment was selected from the intriguing *central* area of the data, which offers an interesting central slope and corresponding blur on the 2D image. The dimensions for this final print were 200 x 135 x 255 mm.

—

My intention to build *Untitled_Force* as a complete model through the process of Additive Layer Manufacturing (3D Print) became an impossibility. The AFM scans the surface at such a minute scale that it is impossible to build a direct model of this data at the real scale of 1:1. The only way that we can model that same data and render it into material is to magnify it by at least 20,000 times, and then take small sections – tiny fragments – and assemble them.

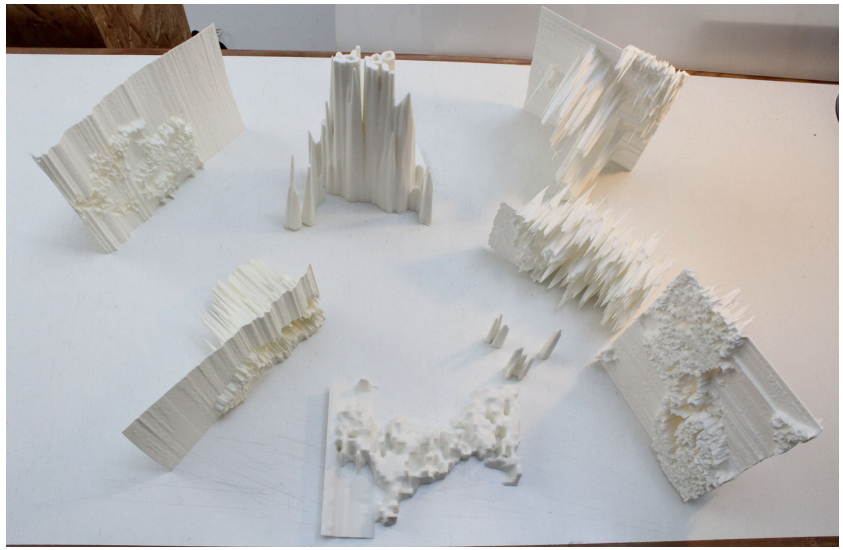


Figure 57: completed 3D Print works in studio (2015)

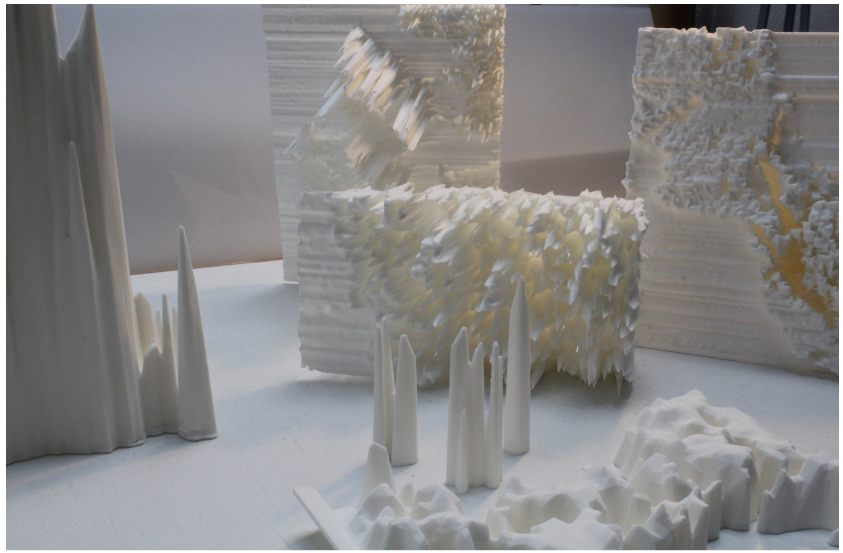


Figure 58: completed 3D Print works in studio (2015)

Despite the cartographic analogy, these 'models' now operate at distinctly different scales in relation to the original data. Through *poetic praxis*, they become 'poetic debris' (La Frenais, 1994, p. 2).

Here, the virtual data derived from the Atomic Force Microscope – from the sensual encounter between the natural material of my body and the touch of the machine – remains as a "dream of information" (Hayles, 2005, p. 62).

The specific (moment of) encounter between my body and the probe of the microscope can be inferred through this series of silent documents, emanating from the event. But we can only see a partial glimpse, or grasp a tiny fragment. The scan itself remains a mystery.

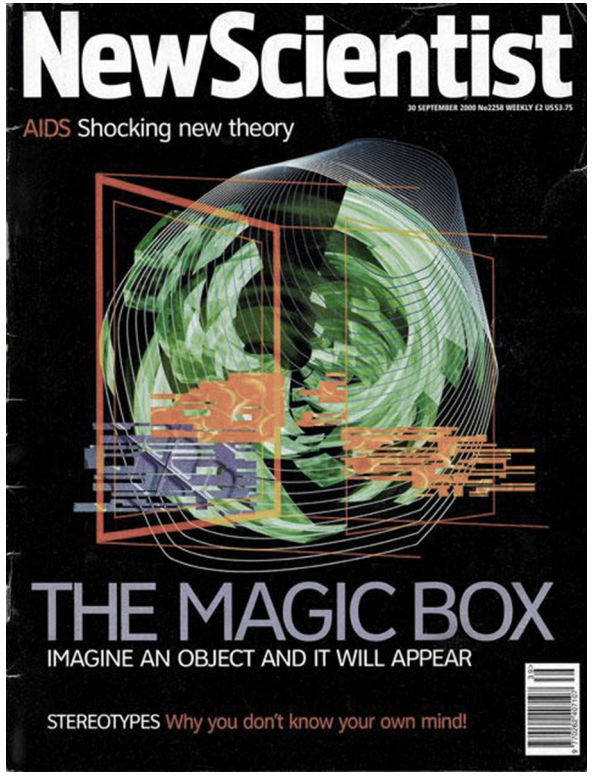


Figure 59: "*Imagine an Object and It Will Appear*" (*New Scientist*, Front Cover, September 2000)

Chapter 6:
Critical view on [working with] 3D Print

Introduction

The final chapter in this section will discuss and reflect upon the 3D Print process in some contextual detail. It comes out of my experience of working with these technological processes over two years at the Centre for Additive Layer Manufacturing (CALM, Exeter University) as outlined in the previous chapter. I will use Jean-François Lyotard's critical discussion of photography in relation to the outcomes of lab practice to consider 3D Print in the contemporary era. In addition to this, I initiated an interview with James Bradbury, Coordinator (2014: Appendix 6) and wider discussions with artists and engineers at Exeter Phoenix;, as part of the public events around the exhibition *NeoReplicants* (November 2012; Appendix 10).

As an emergent technology the narrative around 3D Print is often discussed through a heady haze of projected (science) fiction and fantasy. As a 'friction-free' process, 3D Printing is often conceptualised as equivalent to magic: supplying anything imagined as instantaneous, on-demand goods. The cover of 'New Scientist' (2000) announced the arrival of 3D printing into the domestic environment with the headline, "The Magic Box: Imagine an Object and it will Appear" (London Fieldworks, 2013a and 2013b). In 2013, Christiane Paul's essay, *Objecthoods From the Desktop,* framed the technology's use in the arts by

stating that "sculptures become instantly scalable and printable" (2013, p. 8). Online articles ask: "a technology that *allows almost anyone to turn a digital file into a perfect copy of a physical object* […] Can 3D printing change the world?" (Nusca, 2012, my emphasis).[1]

Thus begins the narrative: a projected fantasy of what the technology is, and how it will instantiate itself in the future, governed by an approach which focuses on an instrumental use of the device, a label and expectation – technics. But, as J. G. Ballard writes, "We live in a world ruled by fictions of every kind […] the fiction is already there – the writer's [or artist's] task is to invent the reality" (Ballard, 1974, p. 8).

The hype and projected fiction surrounding ALM technologies (or 3D Print) could also be viewed as analogous to that generated by nanotechnologies, as described by Hayles in her introduction to *Nanoculture: Implications of the New Technoscience* (2004). She writes: "science fiction remains essential to nanotechnology precisely because it is not yet clear when and how the technology will become actualized" (p. 14). Yet

> "the choice of metaphor is consequential, for it lays down a linguistic track that thought tends to follow and suggests connections that bind new ideas into networks of existing conceptual structures." (p. 13)

[1] Social media and digital platforms such as *Seeker Network* (owned by Discovery Communications, Inc.) have also run articles with dramatic headlines, including "3D Printing Could Save Your Child's Life" (December 2015) and "Fighting Rhino Poaching With a 3D Printer" (August 2013).

In this chapter I will critically reflect upon the technology of '3D Print' practices in relation to two of my research questions:

- At what points does the digital become material?
- What happens in this space: the *surface tension* between the digital and the material?

Following my articulation of *poetic praxis* as an approach towards technology, therefore, the question arises whether these practices are of an instrumental purpose, or whether they could contain something of a more *poetic* resonance?

Figure 60: *Bioforme* light shade (2014)

3D Print or Additive Layer Manufacture

3D printing is a techno-scientific fabrication process, arising through a history of prototyping within the fields of engineering and industrial design. Also known as Rapid Manufacturing (RM) and Additive Layer Manufacturing (ALM), the process was developed and has been used by engineers in industrial manufacturing since the late 1980s.[2] RM is defined as "the use of a computer-aided design (CAD) based automated additive manufacturing process to construct parts that are used directly as finished products or components" (Hopkinson et al., 2006:1). Similarly, a more detailed definition of 3D Print is as follows:

> "A 3D printer is a computer-controlled machine which can fabricate physical objects by depositing or solidifying materials in layers. Each 3D printed layer corresponds to the cross-sectional shape of the object being built. One layer is printed on top of another, and each layer is bonded to the next, creating a continuous, monolithic object." (Walters & Davies, 2010)[3]

Coming out of an industrial engineering paradigm, these last few years have seen an exponential increase in the application of 3D Printing for other areas, including manufacturing, medicine, and interior and fashion design. However, the workflow when using this technology has remained largely the same: the practitioner develops a virtual model using

[2] The first system was stereolithography, developed by Charles W. Hull in 1987 (Interview with James Bradbury, Appendix 6).

[3] The technique of creating a virtual object, slicing it up layer by layer, and then using that slice-data to create an object, has been part of the philosophy since its inception (Interview with James Bradbury, p. vii, Appendix 6).

computer aided design (CAD) software. Alternatively, virtual models are created using a 3D scanner to digitise existing objects, which can then be adapted and altered within the CAD software (Appendix 6, p. viii and p. xi).

ALM or 3D print has been posited as the "Next Industrial Revolution" (Anderson, 2012) and the "Industrial Revolution for the Digital Age" (Hopkinson et al., 2006), where *atoms are the new bits* (Anderson, 2010). And there are innumerable positives to this process: ALM can build complex geometries – models with moving parts and interior forms; more than one type of polymer can be used within the same structure; and when compared to economies of scale within mass production, the manufacture of bespoke complex shapes is relatively inexpensive. As the financial cost of the machines has reduced, availability has increased, and the viability of 3D print has become more commonplace. Many architects, designers and artists now use CAD packages and automated planning systems to produce virtual models, which are then fabricated in nylon, aluminium or plaster (see: *NeoReplicants* 2012 and *"Out of Hand: Materialising the Post Digital",* Labaco, 2013). Here, designers across different fields work with computer-based algorithms and schemata including mathematics, data mapping, symmetry and tiling, to mimic biomorphic structures and to simulate physical occurrences, such as plant growth or water flow (Labaco, p. 19).

> "Advanced mathematical theories play a fundamental role in the creation of three-dimensional forms […] these algorithms map out mathematical space into diagrams with distinctive angles, facets and whorls. This data is then translated into physical objects by machines using 3D printing." (p. 73)

As scale becomes nothing more than a single keystroke activated in the modelling software, the same modelling tools can be used for jewellery, furniture and large-scale building design. Manifold examples can be seen both online and at international trade fairs, including the expanding worldwide enterprise *3DPrintShow*.[4]

However, there are a number of issues with how 3D printing has been conceptualised as a process, particularly its instrumentality as techno-scientific tool, and how 3D Print is discussed in relation to its materiality. Although potentially a radical process, 3D Print often replicates a great deal of *old* thinking and concepts. But through my artistic research, *poetic praxis*, I propose that there can be a different approach: that we can consider 3D Printing as an instrumental tool or alternatively, that we can consider it by "intuitive or imaginative means" (Hiller, 2008, p. 25).

[4] One of the first objects I made as part of this research project was exhibited in the Art Exhibition of *3DPrintShow* London 2013, see Appendix 11.

Techno-scientific Lab Processes

In his essay, *Presenting the Unpresentable: The Sublime* (1982), Jean-François Lyotard comments that photography has become the dominant means of image making in the post-industrial techno-scientific complex. He refers to this process as the "production of beautiful images" (p. 132), making a distinction between the concept of 'beauty' as the output of knowledge-led industrial lab-based processes for public consumption, and something far more enigmatic; the sublime. He articulates this as follows:

> "The widespread introduction of industrial and post-industrial techno-sciences, of which the invention of photography is only one aspect, evidently signifies painstaking programming, by means of optical, chemical and photo-electronic processes, of the production of *beautiful images*. These images immediately bear the stamp of the laws of knowledge […] The person for whom these *beautiful* pictures are intended is a consumer of finished products. Photography's infallibility is that of *the perfectly programmed;* its beauty is that of Voyager II."
> (p. 132, my emphasis)

He then goes on to ask what has happened to the fine arts, since photography has relieved painting of its representational remit. Painting, he surmises, has become a question.[5] By asking 'What is Painting?', the arts become a philosophical enquiry, and as such, "the pictorial avant-garde," has "responded to painting's 'impossibility' by engaging in research" (p. 133-134):

> "many other presuppositions were questioned plastically by the various avant-gardes […] They set about to revolutionise the supposed visual givens in order to reveal that *the field of vision simultaneously conceals and needs the invisible* […] *the field opened by the aesthetics of the sublime*." (p. 133, my emphasis)

Considering the practice of photography as an outcome of techno-scientific lab processes, Lyotard distinguishes between an aesthetic of 'beauty', in which the 'perfect' images' are created by the "infinite ability of science, of technology, of capitalism, to realise" (p. 132); and an aesthetic of the sublime, which alludes more towards "the invisible within the visual" (p. 134), towards the *abstract*.

Some 30 years later, we can apply Lyotard's thinking to processes of 3D printing. By replacing the word photography with 3D Printing, we can see how the process of manufacture is similarly perceived; used for an instrumental rendering:

> "The widespread introduction of industrial and post-industrial techno-sciences, of which the invention of [3D Printing] is only one aspect, evidently signifies painstaking programming, by means of optical, chemical and photo-electronic processes, of the production of *beautiful images*." (p. 132)

We can speak of 3D print technologies as bearing "the stamp of laws of [contemporary] knowledge" and fulfilling the role of the perfectly programmed, finished product. In the lab, making is governed by knowledge practices, and the "infinite ability to realise" (p. 132). As I discovered in my interview with James Bradbury, in his experience of working with Additive Manufacturing, it was *Airbus* who were looking at

[5] Or, after Heidegger, we could also add a *questioning.*

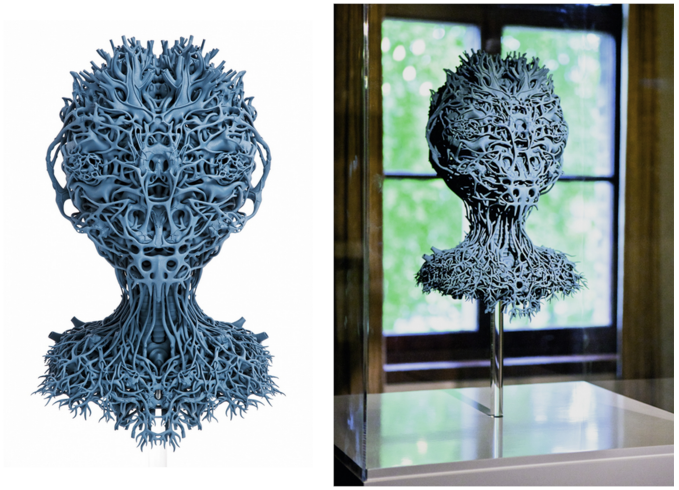


Figure 61: Nick Ervinck *AGRIEBORZ* (2009-2010)
3D Print 53 x 34 x 33 cm

"the image of a *perfectly symmetrical* cyborg figure. […] Working in a close parallel to science, Ervinck is able to develop new realities that can in turn inspire scientists." (Ervinck, 2016, my emphasis)

ways to further develop these technologies, their uses and applications (p. iii). "Airbus Group are a global leader in aeronautics, space and defence-related services, creating cutting-edge technology" (Airbus 2016).

In the lab, making is governed by knowledge practices; […] "modes of making concrete the infinity of ideas. Knowing all, being capable of all, having all, are their horizons – and horizons extend to infinity" (p.132). The technics of the machinery, as claimed by Electro Optical Systems (EOS),[6]

> "makes design-driven production a reality. Innovative EOS technology offers designers the greatest possible freedom and enables extremely complex structures to be manufactured […] *Every possible form that can be constructed with a 3D CAD program can also be produced using innovative laser sintering technology.* There are no restrictions, not even when it comes to the production of hollow structures." (EOS 2015, my emphasis)

Lyotard's writing offers an enhanced critical perspective on the excitable world of 3D print, which serves to highlight its fallibility. We can now look critically at the works shown as part of *3DPrintShow*, particularly those by Joshua Harker and Nick Ervinck (Figure 61), and, see them as examples of beauty:

> "[…] not just beautiful, but too beautiful. Something is inherent in this 'too': an infinity; not the indeterminacy of a feeling, but the infinite ability of science, of technology, of capitalism, to realise.

[6] EOS (Electro Optical Systems) were founded in 1989, Munich, Germany and are one of the main producers of industrial 3D Print Technology. They manufacture the Formiga P100 (used for this project). http://www.eos.info

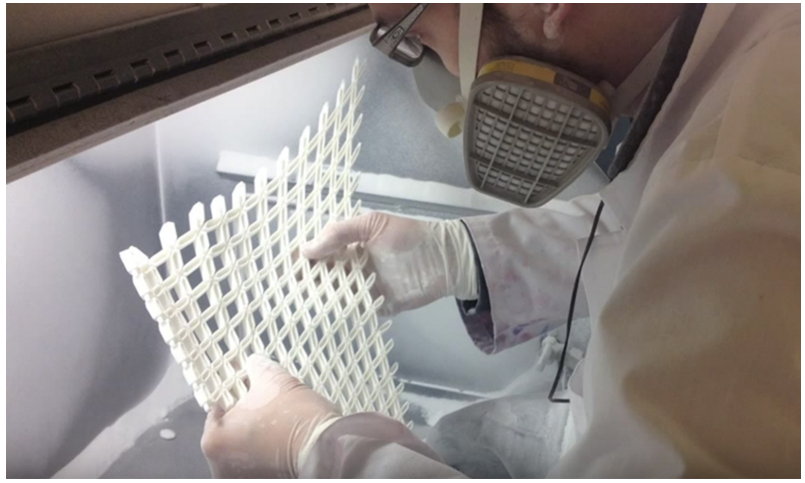


Figure 62: Bitonti 2014 Video still from *Designer Francis Bitonti talks about his 3D-printed dress for Dita von Teese*.

> […] the hardness of industrial beauty contains the infinity of techno-scientific and economic reasons." (p. 132)

For Lyotard, techno-scientific practices govern "the hardware involved in producing the machine that produces" (p. 132). Reading this highlights the fact that a vast proportion of contemporary 3D printed artworks are simply a demonstration of the flex of technical muscle, without accommodating any thoughtful engagement with the practice; they offer the equivalent of a trade show platform for the manufacturer's technology. In addition to this, the process is often used as a tool for *replication;* the same online articles that ask "Can 3D printing change the world?", frame the technology as allowing "almost anyone to turn a digital file into *a perfect copy of a physical object*" (Nusca, 2012).

Furthermore, when used by some artists, the process simply replicates a lot of old thinking around ideas of 'beauty', form and the body, regurgitating old ideas of what art *is* under the guise of a novel medium (a prevalent desire to replicate of an idealised version of the female form, for example). The creation of a 3D Printed dress for Dita von Teese (2013), shows the technology being framed in terms of a male fetish, as her body becomes clothed in 3D Printed plastic. Through her study of *The Female Nude*, Lynda Nead posits that, more than any other subject, the female nude "clothed in art" becomes a symbol for cultural achievement (1992, p. 1).

> "the representation of the female body […] is a metaphor. […] It symbolises the transformation of the base matter of nature into the elevated forms of culture." (p. 2)

As a site for representation and fetish "this requirement applies to representations of the female body in high and mass culture" (p. 11). Laura Mulvey suggests that "the smooth glossy body polished by photography [here read 3D Print], is a defense against an anxiety-provoking, uneasy and uncanny body" (Mulvey, cited in Betterton, 1996, p. 135). Counter to the work of Helen Chadwick, for example, here the fetishised *surface* of the female body (coated in 3D Print) masks the abject nature of the 'marginal matter' contained in its interior.

My project and approach

Couched in the unproblematic and seamless transfer from the 'virtual' model of the imagination behind the screen to its surfacing in the real world, the temptation is to be caught up in the technological; fixated by its simplicity and hypnotised by its instrumentality (Heidegger, 1977, p. 5).

Rather than taking the design-led instrumental approach towards the practice of 3D Print, my project took an alternative approach which allowed for subtle nuances to emerge: "the indeterminacy of feeling" (Lyotard, p. 135). Whilst at the beginning of the project I experimented with CAD Google SketchUp software, I found it unrewarding to simply model, through a pre-ordained gridded space. I was much more interested in allowing something to develop, crystalise and form, just like the tacit models. My approach was therefore different to a CAD design-based approach.

In taking the digital data from one field of 'modelling' (i.e. Atomic Force Microscopy) and placing it into the context of the 3D modelling software, I re-contextualised the data and re-appropriated its intended function. As James Bradbury stated in our discussion:

> "I think with your particular project, the really interesting and challenging thing was not just using CAD, but taking the data that you had been able to obtain from your AFM and using that; how you had to convert that digital data into a form that you were able to then produce physically. Because you're talking about the detail, about the magnification; literally all these challenges that we had, to be able to come up with your final, physical object was using that philosophy.
>
> So rather than just coming up with using a Computer Aided Design, a CAD software package, and just coming up with a design onscreen – actually that's the simple approach compared to what we had to do with yourself. So really it was a different approach, certainly at the beginning." (Appendix 6, p. viii)

Rather than consider the relation between the dataset and the model – the virtual image and the prototype or print as a seamless translation – I explored this distance, prising it apart. Through an approach that questions the process of 3D manufacture, taking the digital model, my project rendered the process visible.

> "As regards your particular project, it's pushed the boundaries of what the technology was certainly able to do." (p. ix)
>
> "It's a really interesting way of trying to understand, 'what are the limitations, what are the challenges currently with this particular process'." (p. xi)

For Lyotard the role of the artist is a "responsibility to the question of the nondemonstrable":

> "to reveal that *the field of vision simultaneously conceals and needs the invisible* […] *the field opened by the aesthetics of the sublime.*" (p. 133, my emphasis)

Here then, the artist's responsibility is one that asks *into* that which is invisible – the abstract – foregrounding an engagement with the sublime.[7] Otherwise, Lyotard warns, "the indeterminate since it does not allow for precision, will have to be eliminated, and with it goes feeling" (p. 132).

It is interesting and productive to consider my engagement as an artist with the lab practices and methods of 3D printing in relation to Lyotard's critical essay. In stating that the artist's responsibility is "to the question of the nondemonstrable" (p. 135), he is foregrounding here my philosophical relation to the practice – *poetic praxis* as an artistic research enquiry.

To conclude Part Two (Methodology) here, I have now addressed three of my research questions:

- How does data 'meet' the biological or natural?

The first question has been addressed through the haptic, performative process of the AFM and my resulting data: *Untitled_Force.*

- At what points does the digital become material?

The second question has been addressed through the lab practice, making the series of six 3D Prints.

- What happens in this space: the surface tension between the digital and the material?

The third question has been addressed by acknowledging the difference in artistic approaches.

To sum up this methodology, therefore, we can see that normally the digital becomes material through a design-led process: CAD. My approach, however, was to introduce another three-dimensional form or data object file into this instrumental process. Coming from the Atomic Force Microscope, *Untitled_Force* as data, was never intended to be printed or realised as a three-dimensional object.

Due to the incredible detail of the original AFM scan file, the process of translation into a 3D object became problematic, exposing this area of difficulty. The computers' processing power struggled with handling the vast amounts of data; the laser, whilst attempting to build further parts, often melted the details in the model itself. The limits of the technology's capacities to build were reached in the quest for instrumental use, the edges of its capabilities being exposed.

[7] Or, as Ballard might say, "to invent the reality".

Through my research questions and practice-based enquiry I have not only been asking at what points does the digital become material, but have considered *how* the digital becomes material. My position, then, is that typically the digital becomes material through a process of instrumental design. Through my practice I reject this, formulating instead an alternative approach in which process, materiality and indeterminacy are central.

As a result of this project, when considering my third research question (what happens in this space: the surface tension between the digital and the material?), we can now ask: is this a space of indeterminacy? 'What happens in this space' can follow the "perfect programming" (Lyotard) logic of the techno-scientific lab process through an instrumental method. However, this "concretisation of an objective infinity" is the end of poetics (Lyotard, p. 133).

Alternatively, therefore, I present a methodology of artistic research, which in my project, I figure as the poetic, intuitive approach of *poetic praxis*. Using this approach to work with the technologies, through the demands of practice, questions can be asked and processes can be demonstrated. We therefore return to our question of approach. This method of *poetic praxis* can respond to the process whilst remaining open to the sublime; the abstract: the art of the open.

[BLANK PAGE]

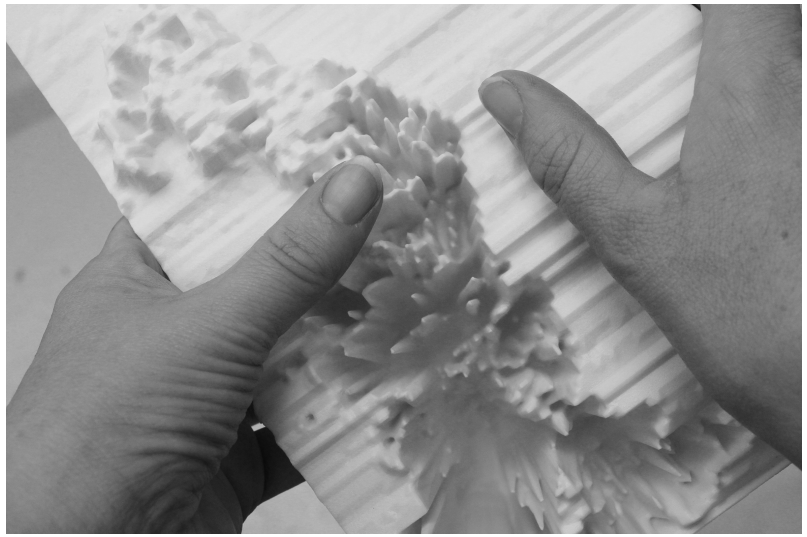


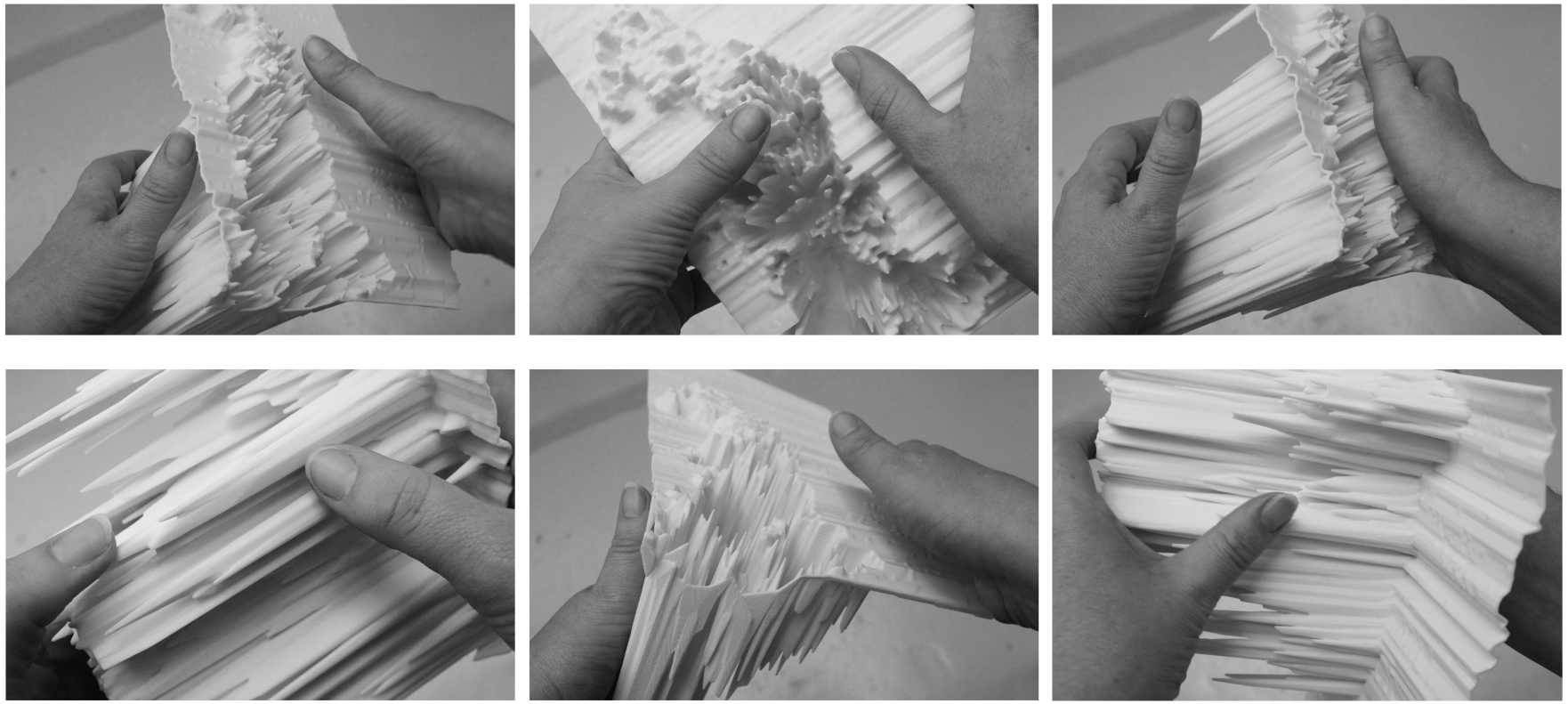
Figure 63: *The object becomes tactile:* holding *Fragment 1, Untitled_Force.* Self portrait, studio (2015)

Overleaf
Figure 64: *The object becomes tactile:* holding *Fragment 1, Untitled_Force.* Self portrait, studio (2015)

Part Three

Chapter 7: The Work as Material Metaphor

These objects now reconceive the blood as something we are able to touch, to apprehend physically, on a much larger scale. The object becomes haptic, tactile; and we sense the bio-data as physical form.



Introduction

In Part Three of the exegesis, I will be addressing the final research question:

- How does the body re-encounter or re-engage with this material, this fabric?

In this section I will be reading the works through different perspectives and theoretical positions, considering them as *Boundary Objects* (Borgdorff 2012), material objects and metaphors, and also introducing the notion of glitch or noise (as further indeterminacy) into the process. Through doing so, the works become fertile and productive spaces for imaginative engagement, and lead to further reflection upon wider social and cultural issues and the contexts in which they were made.

To clarify, 'the body' in this research question stands for both myself (as the embodied artist and author of the research) and the embodied audience member or participant *reader* of the work. I also distinguish here between *material*, as a broader term for physical substance or matter, and *fabric*. My interpretation of fabric is that it implies something that has been woven or *made:* something that has come out of a process of fabrication. This fabric could be physical, such as cloth or textile or a framework that is more intangible, such as the social or cultural fabric.

Fabrication can mean manufacture, which implies scale and industry, and it also implies a technological process, all of which can be produced and explored within an arts practice.

As we saw in the previous chapter on approaches to 3D Print, the role of metaphor in the spaces between culture, science and technology is crucially important (Hayles, 2004). New technologies are infused with fiction and speculative imaginings, "because it is not yet clear when and how the technology will become actualised" (p. 14). In this respect, science is in need of the cultural imaginary to expand its relevance and scope through providing new metaphors.[1] As Joan Fujimura writes:

> "imagination is a social practice deployed in the production of science and technology. Creating future imaginaries is a major part of scientists' work in the new biotechnologies […] genetics, artificial intelligence and robotics research." (2003, p. 176)

As an application of techno-science, 3D printing is part of this dialogue, sitting between science, technology, data visualization, industry and commerce. It is subject to the same speculations, financial and emotional investment, and (often) fantastical hype.

My PhD research brings together the materiality of 3D Print, in close combination with the material of my body, uncovering the slippages between the sensorial and techno-scientific approaches to the world. Metaphors work as a categorical shift, from one context to another. Metaphors are necessary in this field of imaginative practice, or *poetic praxis,* as they both concretise thinking and help to open it up, bringing the two uneasy poles of science and art together. [2]

N. Katherine Hayles (2002) introduces the concept of 'material metaphors' to articulate the relationship between physical artefacts and the signs that they convey, particularly those that are produced by "inscription technologies", which she defines as devices that "initiate material changes that can be read as marks" (2002, p. 24). Hayles' "inscription technologies" include the printed page (including books), film, video, and also imagery produced by medical technologies, including Ultrasound (p. 24). In this research enquiry, the Atomic Force Microscope as well as the 3D modelling software *MeshLab* (2012) and 3D Print (or ALM) can be added to Hayles' definition of "inscription technologies". They initiate material changes that are read as marks – metaphors that instantiate meaning through their materiality. In the following section I will discuss possible readings and meanings of the works through their material and metaphorical significance.

[1] I am thinking that this can be seen in the field of *Synthetic Aesthetics* (artists Daisy Ginsberg, Oron Catts et al.) whose work disrupts bio-engineer's metaphors of BioBricks to produce new, often unsettling work that disrupts the ease with which science often simply follows the engineering paradigm). *Synthesis* residency, Arts Catalyst (2011).

[2] Ref. *Solaris* as I discussed in my Introduction.

Boundary Objects

Henk Borgdorff's terms 'boundary work' and 'boundary object' are useful for thinking through the works here, as they necessarily move within and across different disciplines and contexts. Borgdorff describes the term 'boundary work' as that existing along the borderlines between different contexts (2012, pp. 117-123). Here, Borgdorff means that an object has one meaning in a certain research environment and another in a second research environment: for Borgdorff a 'boundary object' is "an object that changes its ontological and epistemological nature depending on the context in which it is used" (p. 117). *Untitled_Force,* following Borgdorff's definition, is a 'boundary object'.

Untitled_Force comes out of a scientific academic research environment; it originated in techno-scientific laboratories and was made possible only by access to this specialist equipment. In an engineering research environment, the work consists of a series of challenging, problem-solving exercises. As a 3D Print work, problems of scale, detail, form, temperature and glitch play a real role in the realisation and delivery of the work. As I discussed in Chapter 5, an artist making the work in collaboration with an engineer can reveal many limitations of the usual process. The norms of making 3D Print works, such those of the technical software and hardware, as well as the discoveries made during the process, can feed into the engineer's outlook, practice and method (which is *impact*, in academic terms).[3]

Yet *Untitled_Force* also operates in an art context. Here it explores materials and processes, but its primary value lies in metaphor – in interpretive *meaning*. Borgdorff states that artistic research is, in its essence, boundary work, "as it places itself on the border between academia and the art world" (p. 117). These two contexts make artistic research, with its links to the 'real world outside', a very good example of modern, contemporary academic research (p. 119). To recall Michael Biggs here, the key difference, even when exploring similar processes, is that artistic research will look at how the work sits in its contextual relationship to other artworks and artists (Biggs, 2004, p. 3). In this final section, then, I shall consider these works in terms of their metaphorical and material significance, as indexical sculptures that point to a fusion of bio-machine. This material metaphor will be further explored in the final chapter, when I consider the sculptures' materiality: Nylon 12.

After bringing these 3D Printed objects into the studio, I was able to reflect on these articulations of techno-scientific processes in an artistic context of image-making, performative practice and installation. I spent

[3] As I demonstrate through my research, bringing artistic practice and a poetic approach into this field, can open dialogue and possibilities for these technologies, to new *unforeseen* possibilities. As James Bradbury, CALM Coordinator and Research Fellow, confirmed, "as regards your particular project, it's pushed the boundaries of what the technology was certainly able to do" (Appendix 6, p. ix).

extended periods considering the sculptures as *fragments,* asking what to do with them? How to present and disclose them? I experimented with light (an illuminated light box); projection (as screens or surfaces); and as sculptural assemblage with objects such as mirrors and glass (Portfolio, pp. 36, 42 and 45).

The works were then tested, through presenting them in different environments and contexts, leading to conversations with artists, academics and public alike. I presented the work in academic contexts (Bournemouth University; *Fascinate*, Falmouth University, 2013; *Generative Constraints*, Royal Holloway & Kingston Universities, 2013; and Goldsmiths, 2013); and in art contexts (the Art Exhibition at *3DPrintShow,* London, 2013; Spike Open, Bristol, 2013 and 2016; and *NeoReplicants*, Exeter, 2012). Through these performative tests I discovered that it was important to reference the processes by which the works were made within an exhibition. I wanted to show that the artworks were not simply a result of instrumental rendering, but had developed through the *poetic praxis* of artistic research. This entailed a more considered approach, which drew from my original experiments in the studio – objects and qualities, such as depth, reflection and surface. Contextual information was also necessary in order to frame the work in its reception and understanding by an audience.

The resulting works were therefore presented as sculptural installations in the exhibitions: CONTACT/SURFACE, Exeter (November to December 2015), and *Zero Landscape*, Bristol (January to February 2016). Through a peer critique that I initiated, I found that by engaging with the works, the audience necessarily engaged with the themes of the PhD project. As such, the sculptural works became embodiments of the artistic research. I shall discuss these aspects further in the next chapter.

Glitch, Noise or Error

After making the images and 3D prints from the AFM data, I had a limited email correspondence with Genhua Pan, Professor of Spintronics at Plymouth University, and the AFM operator during the scan made there. The objects had prompted me to question the original data and I was intrigued by these new sculptural forms. I wrote to him for clarification, asking him to explain how the objects related to the original scan data and the AFM process itself. In his response, he wrote:

> "I am not quite sure why you get double sided structure, unless you combined two channels of data in one. The AFM stores the forward scan image and backward scan image separately and they are effectively mirror images to each other if the machine is perfectly optimised. However they would look different if not. If you put both forward scan and backward scan images in one, you may get a two-sided image. Otherwise, I don't how you get that." (Appendix 13)

"If the machine is perfectly optimised." This comment stayed with me and reverberated for some time. I had looked to science for an answer, expecting an explanation for the data, but this had left me with a further doubt: it led me to consider the possibility that there had been a substantial error or glitch in the process. This led onto further questioning: had a glitch in the machine's performance during the

scanning process led to the development of these particular forms? Yet, if so, how then could the original image look so composed?

> "Oscillations create the glitch as a state of computational exception, as opposed to other technical forms […] a conspicuousness that breaks the everyday experience of things." (Berry et al., p. 16)

The notion of glitch brings a further sense of indeterminacy and ambiguity to the work. In a traditional representational idiom, for example, or if seen as an outcome of scientific practice, it would lead us to question the verifiability of what we were looking at, as a True, accurate depiction of blood, through the medium of the AFM. However, we can also consider the glitch as a technical artefact – as a means of *reflecting* (following Heidegger) on the wider context of "computational sense making" (Berry)[4]; as a way of revealing what *else* comes to presence in technology:

> "The notion of the glitch, as a technical artefact, whether accidental, system-generated, pragmatically or aesthetically created, contains within it a framework for thinking through the digital." (Berry et. al., 2013, p. 2)

[4] According to Berry et. al., computational sense-making is defined as when "machines process, format, organize and understand the world, especially as this is entangled with competing notions of (post) humanism" (p. 4).

New Aesthetic

One way of reading *Untitled_Force,* as a potential glitch is as a New Aesthetic [NA] image. Rather than Bridle's concept,[5] however, Curt Cloninger's *Manifesto of a Theory of the New Aesthetic* (2012) roots the term in a long history of arts practice and philosophy, aligning the form (the image) as an outcome of process, and as a contemporary manifestation of Process Art:

> "The NA image is the incidental visual residue of the performance or enactment of a process […] a trace, a remnant, a remainder, a residue, a (potential) clue. The 'subject' of the NA image […] is the process itself. In this sense, the New Aesthetic is akin to process art […] It reveals more about the processes and systems that 'produced' it than it does about itself." (2012)

Untitled_Force as New Aesthetic image therefore arises as an *accumulation* of technological process – incremental increases that have distorted or distended the form. Cloninger continues:

> "NA images are incidentally thrown into the world by those processes. The way backwards from the images toward the processes themselves is much more complicated than simply intellectually thinking about what these images look 'like'. We initially apperceive NA images bodily and affectively. They are freaky. They trip us out. Only later are we able to reflect on them analytically, letting their own systemic contours and folds guide our theoretical thought." (2012)

As glitch or noise – as outcomes of an accumulation of machinic processes – these works bear an indexical trace of the machine's 'touch'.

[5] James Bridle is discussed briefly in Chapter 4.

There is no longer any sense of transparency: the AFM is not simply a (representational) window or frame onto an 'Ultrasmall'[6] landscape, but rather, here, the machine has *agency*. The objects reveal the touch of the machine as something strange, uncanny, unsettling. This is not mimesis, but something other, something for which we have no referent. We can no longer recognise this data as a blood sample solely produced by my (human) body; rather it becomes a fusion of the bio-machine. To recall Haraway, it is no longer "clear who makes and who is made in the relation between human and machine" (1991, p. 177). As a theorised and fabricated hybrid of body and machine, *Untitled_Force* becomes one of Haraway's cyborgs: "a hybrid of machine and organism, a creature of social reality as well as a creature of fiction" (1991, p. 149). As a condensed image of both imagination and material reality (p. 150), these objects are offered as co-creations. As Cloninger writes:

> "We recognize ourselves in NA images, but also something other than ourselves…ourselves complicated, enmeshed, *othered*." (2012)

[6] Don Ihde (2010) names the scientific "objects" of techno-science "The Ultrasmall": "Biotechnology deals with genetic strands, DNA, RNA, proteins, and the like. Nanotechnology deals with objects at the molecular and atomic levels. Information is digitally processed and encoded, fitting into ever more compact chips and transmission processes. The same applies to communication technologies, tied into networks that include satellites, wireless, and broadband systems. And in much scientific imaging, objects as small as individual photons, ion streams, and electron streams are utilised, particularly to go below even the early twentieth century limits of optical light. In short, these submicroscopic objects are the Ultrasmall." (pp. 3-4)

The Body in the Work

The notion of the glitch as a key performative moment or artefact not only contains within it a framework for thinking through the technological, but also becomes a means to reflect on the materiality of the body in this contested and complex relationship. As I said previously, the excitement of this artistic research is to see what happens when frictions, inconsistencies and bodies meet. To return to the question:

- How does the body re-encounter or re-engage with this material, this fabric?

In this project, the blood smeared onto a slide stands for my human, fleshy body as corporeal substance. As Helen Molesworth states, "the origin of the work of art is the artist's body – in the pressing and smearing, in the dailiness of bodily functions, in the question 'what kinds of marks can I make?'" (1993, p. 79). However a smear is also "a sample of tissue or other material taken from part of the body, spread thinly on a microscope slide for examination, typically for medical diagnosis" (Apple Dictionary 2.2.1). This smear on the slide has the implication of a scientifics of *scrutiny,* of blood as material: the oxygenating fluid circulating in the body, which contains a wealth of information, including blood type, genetic identity, and the materials for DNA mapping and cloning. We are reminded here (after Ziarek, 2005) that the blood can be read and processed as data: "In the information age […] everything is determined in terms of its availability as information" (p. 216).

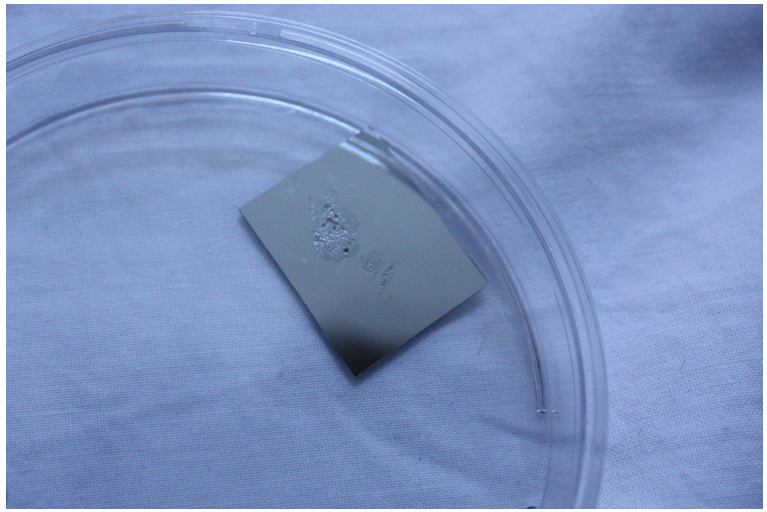


Figure 65: original slide (2011)

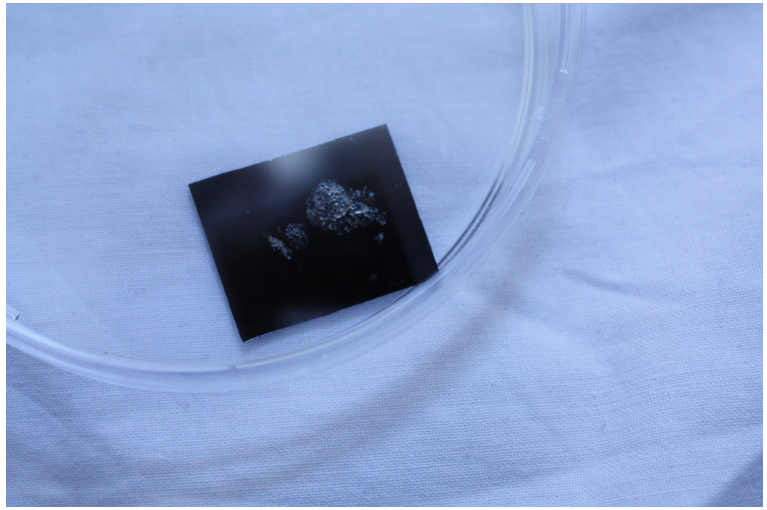


Figure 66: original slide, alternate view (2011)

In addition to this, blood still has many symbolic and cultural associations, including violence, passion and the "sensual nature of man" (Chambers Dictionary 2014). In cultural practices, human bodily materials are invested with highly symbolic power, reflecting complex emotional and visceral entanglements. In speaking about using blood in her work, for example, artist Ana Mendieta said: "I think it's a very powerful, magical thing. I don't see it as a negative force" (Quoted by Maggie Nelson, 2011, p. 79).[7]

Other examples of contemporary artists who work with (human) biomaterial as an explicit medium in their practice include Mark Quinn's ongoing works *Self* (1991); Andres Serrano; Helen Chadwick; and performance artists Poppy Jackson and Franko B. Amelia Jones writes that the artist's body has surfaced "as a locus of the self and the site where the public domain meets the private, where the social is negotiated, produced and made sense of" (2012, pp. 20-21).[8]

---

[7] Ana Mendieta: *People looking at Blood, Moffitt* (1973); *Untitled (Self-Portrait With Blood)* (1973); *Untitled (Rape Scene)* (1973); *Untitled (Mutilated Body on Landscape)* (1973); *Blood Writing* (1973); and *Untitled (Body Tracks)* (1974).

[8] There is an incredibly rich history of artists whose (performative) bodies are at the core of their artistic practice; artists who probe, explore, and re-position their bodies through performance, re-presentation and documentation. From Duchamp's *Wayward Landscape* (1946) through the emergence of the radical performance scene initiated in the 1960's, to the present day. I will not attempt to trace this fifty-year history here; these artists can be found in the pages of tomes, including: *Body Art / Performing the Subject*, Amelia Jones, 1998; *The Body in Contemporary Art,* Sally O'Reilly, 2009; and *The Artist's Body,* Tracey Warr, 2000 updated 2012.

The use of human biomatter as an art medium then opens up an intriguing cultural space to critically reflect upon the relationships between our biology and technology, materiality and ethics, as well as in the production of cultural meaning. Artists have been negotiating and registering the effects of the body "as saturated in and through technology, experienced – in its fragmented prosthetic forms – through socially inflected technologies of reproduction, communication and medical intervention" (p. 41). As I discuss here, relating blood to the body, and the relationship between the body and technology, brings a whole host of cultural associations and assumptions to the fore:

> "When an artist walks into their studio they bring with them all their perceptions, experiences, memories, rationalisations, knowledge, but they bring also their body twitching with electrical and chemical reactions, crawling with an invisible quantum life and motivation, the microflora and fauna of genes, cells, DNA and enzymes." (Warr, 1998, p. 121)

Firstly, then, I have made a series of works that are derived from material from my body, "twitching with electrical and chemical reactions" (Warr, 1998, p. 121); my bloody smear on the slide. Secondly, there is an experiential aspect: I have brought my senses, my intuition, my physical responses, and perceptual data into my research methodology.

Reading these works as *indexical documents of presence.*

Following Rosalind Krauss, we can also read the AFM scan – and indeed all the works in *Untitled_Force* that stem from this original data – as instances of an indexical practice:

> "Indexes establish their meaning along the axis of a physical relationship to their referents. They are the marks or traces of a particular cause, and that cause is the thing to which they refer, the object they signify. Into the category of the index, we would place physical traces…" (Krauss, 1977, p. 70)

When we read *Untitled_Force* as an index, we see that my body is present within the work by means of an indexical trace (my blood). The smear of my blood on the slide is primary, like the hand or footprint. As Warr confirms, "Physical traces – stains, footprints, body casts, shadows – have all been identified as indexes rather than symbols" (2010, p. 28).

There is therefore a continued physical relationship with the subject; with my body: from the performative scan, reading the physical trace of my body (the blood in the laboratory), through to its emergence as a synthetic object in the 3D Print machine. When Krauss writes of Denis Oppenheim's *Identity Stretch* (1975), she states that "the meaning of this work is focused on the pure installation of *presence* by means of the index" (p. 8, my emphasis). Oppenheim magnifies his own thumbprint thousands of times, and then lays it in asphalt, fixing its traces.

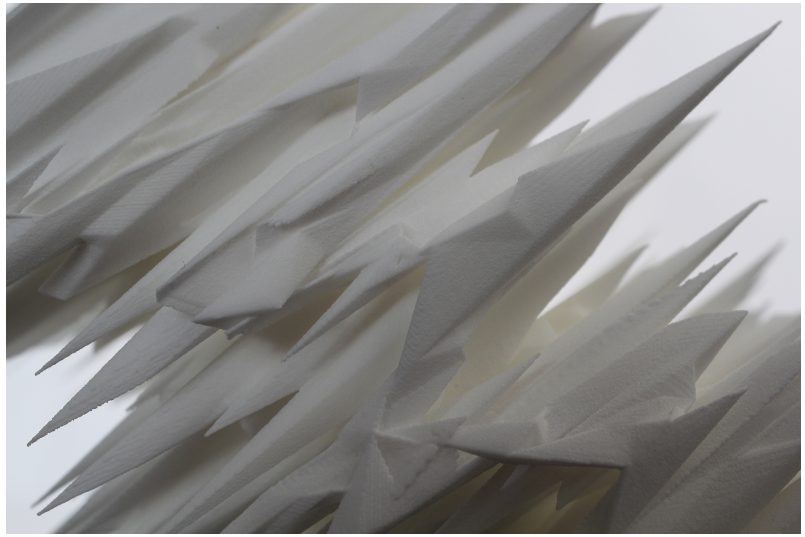


Figure 67: *Untitled_Force Fragment No. 4* (detail) (2015)

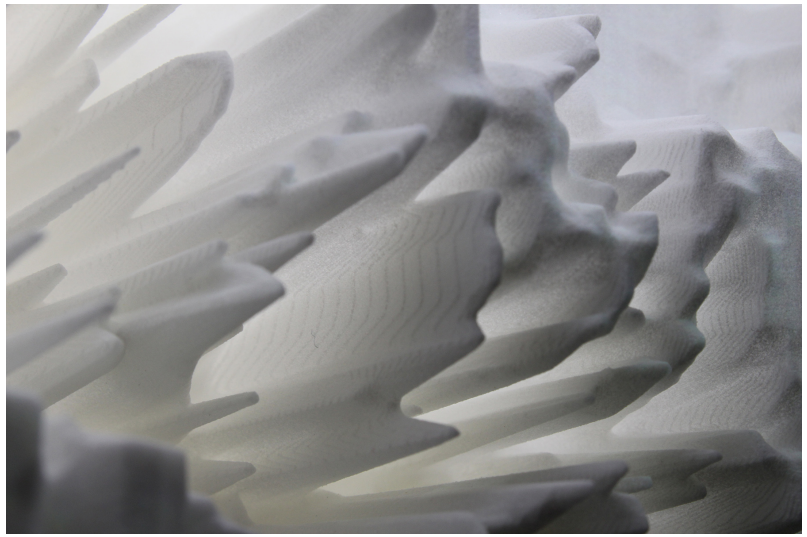


Figure 68: *Untitled_Force Fragment No. 1* (detail) (2013)

By bringing together Cloninger's definitions of the New Aesthetic image as "the incidental visual residue of the performance or enactment of a process" (p. 38), in combination with Krauss' descriptions of the index, the work *Untitled_Force* becomes *doubly-indexical*. We can read it as comprised of both my body's and the machine's indexical traces – the two entwined and entangled, as material residues of physical process in *the event.*

As I stated in my introduction, this PhD project is located in and explores the body's negotiations within a wider mediated sphere. What I am *concerned* with are how my research questions can be answered or explored through a poetic mediation of the body, rather than one of *instrumental technics*. One possible reading for these works, therefore, is that they can be read as indexical documents of the *simultaneous* presence of both body and machine, and of the fact that in a contemporary age of miniaturisation and techno-science they are mutually constitutive of each other.[9]

By placing the work into a wider context of body-based practice, we can think about the work in relation to other artworks that draw attention to and question the body as a borderline between the biological and social,

[9] This appears to be confirmed by David Roden's reading of the works in their exhibition at Spike Island (2016). Initiated by seeing the works and subsequent correspondence via social media, Roden suggested that the works "do not simply conceptualise the volatility of existence under conditions of extreme modernity, but harness it in order to better understand it." (email, Appendix 14). Roden is author of *Posthuman Life: Philosophy at the Edge of Human* (2014) and Lecturer in Philosophy at Open University.

and the natural and the cultural, where "political, theoretical and technological changes intersect to produce new knowledges and understandings" (Betterton, 1996, p. 9). In *An Intimate Distance* (1996) Rosemary Betterton focused particularly on the shift in the work of female artists (including Helen Chadwick[10]), who had started to ask what it means to *inhabit* 'the body': a relation between "the problem of *looking* (distance) to the process of *embodiment* (touch)" (p .7), initiated by the premise that

> "Western systems of representation in art *and science* have placed the act of looking at the centre of their enquiry, predicating a certain *distance* between the viewer and what is seen – between the subject and object of vision." (p. 7, my emphasis)

Drawing particularly from feminist scholars including Luce Irigaray, Hélène Cixous, and Julia Kristeva to reimagine a "poetics of the body" (Margaret Whitford, quoted in Betterton, p. 15), Betterton posits that contemporary female artists articulate an imaginative and embodied space. Jane Gallopp clarifies: "the Irigraryan poetics of the body is not an expression of the body but a *poesis*, a creation of the body" (1988, p. 94).

The act of creating (artworks) through a process of looking (at oneself) at a distance, whilst simultaneously connecting to a sense of embodied self through touch, becomes *a circuit,* which the audience (as embodied participants) completes.[11] This circuit leaps the gap: this *Intimate Distance,* this borderline, or space *between* self and Other. It is this to which Chadwick refers in her work, particularly *Enfleshings:* "*The living integrates with other in an infinite continuity of matter, and welcomes difference not as damage but potential*" (1989, p. 97).

Using Betterton's analysis we can read *Untitled_Force* as operating in this field between looking and touch: the original Atomic Force Microscope blood-scan, as a haptic event (of touch) negotiates a relationship between my experiential and biological (female) body and the machine. The work is both intimate, connected to a sense of self and touch, and at the same time places my body figuratively as an image that 'oscillates in the distance' (the remote-sensing / satellite view over an interior landscape) and as the object of representation, research and investigative enquiry. Through the materiality of the 3D Print sculptures, this distance becomes re-negotiated – the object becomes tactile. Thus, the work becomes a rigorous interrogation of self(-image) through machinic processes and materials, which can then be read by an audience and thus inferred to have wider significance.

Through my research enquiry and methodology of *poetic praxis,* I have been exploring this threshold space; this intimate distance between self and Other: the surface tension between the digital and the material (of /

[10] Betterton refers to many artists, but the practices of Mona Hatoum, Cindy Sherman, Orlan and Mary Douglas seem particularly apposite here.

[11] I shall discuss the audience's perception of the work in the next chapter.

from the body). As a series of works, *Untitled_Force* give form to the threshold where my body and embodiment, as corporeal flows and multiple processes, meets machinic intensities, locating this relationship in an image and as a series of sculptures.

These sculptures are articulations, surfaces, fragments. They hint at aspects of embodiment and machinic intensities that are *outside* of visibility and representation: the invisible, "the field opened by the aesthetics of the sublime" (Lyotard, 1982, p. 133), and experiential aspects such as pain. Elaine Scarry (1985) writes that pain is an aspect of embodiment that has a physical reality, yet cannot be perceived directly. Pain itself does not have an object, rather it exists on the threshold of embodiment and imagination – it is invisible. We therefore experience emotion (such as pain, pleasure and intimacy) through means of perception that are 'other' to sight. In contemporary society, technological processes are also invisible: data transmission, Wi-Fi, GPS networks, etc. (as outlined in Chapter 2).

These forms originate from my blood (once inside my body), becoming entangled with the machinic through the touch of the AFM. Highly magnified and given form through a series of additive processes, layer upon layer, these disarticulated fragments lend a material shape to these interactions – these entanglements between body and machine. They exist now as evidence of a process: as material residue, as deposits, fossils, ejected from my body's process of becoming.

Chapter 8:

Exhibiting the Work as Installation

Introduction

In this chapter, I will discuss the artistic research in relation to how it was framed (both spatially and conceptually) for exhibition, and its experience by an audience. I will use this encounter between audience and artwork as a further means of answering my final Research Question:

- How does the body re-encounter or re-engage with this material, this fabric?

Here, I will consider how *Untitled_Force* as a series of works were presented to a public audience as an art exhibition, as a sculptural installation; my aim being that the audience encounter the artworks as embodied participants. It was very important to me that the works were not simply perceived as illustrations of technical processes, nor read as demonstrations of technical proficiency in 3D Print technology. Drawing from audience comments (including the transcription of a peer critique: Appendix 15) I will consider how successfully the work was *encountered* as installation – as "sensorial image" (Wanderley, 1993) or visceral response. Through exhibition and discussion, the artworks became "prisms that reflect externalities and refract within themselves" (Richardson and St. Pierre, 2005, p. 963).

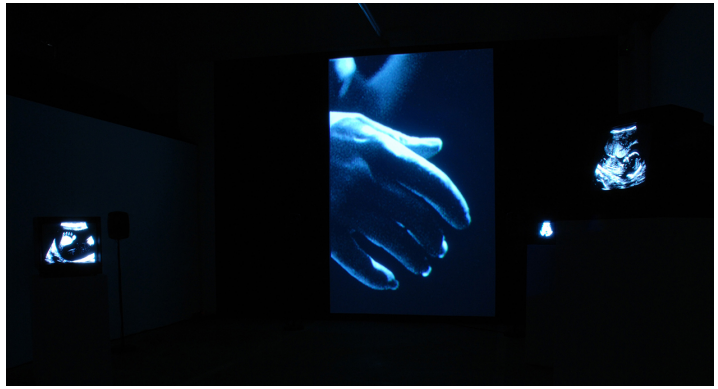


Figure 69: Katy Connor *Aureole* (2007)
Multi-channel Installation at VIVID, Birmingham's Centre for Media Arts

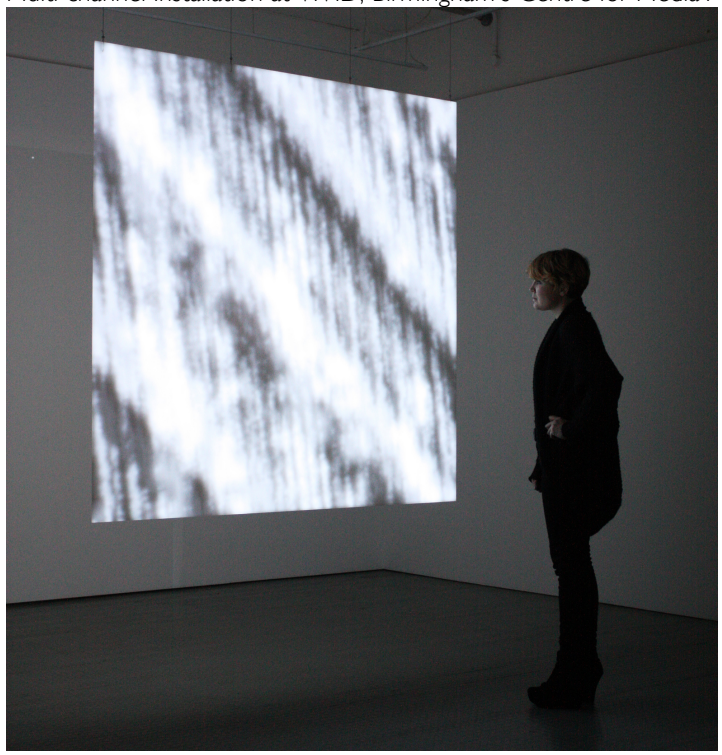


Figure 70: Katy Connor *Pure Flow* (2009) GPS Noise as Poetic abstraction.
A/V Installation at Exeter Phoenix (4-channel audio with suspended screen)
Photograph: Bill Leslie

I presented the work at two public exhibitions: *SURFACE/CONTACT*, a group show at Exeter Phoenix (November to December 2015), and *Zero Landscape,* a solo exhibition installed over two sites in Bristol (January to February 2016).

Installation Art

Drawing from my previous experience in exhibiting work (see Figures 69 and 70), my intention was to present my research using the form or frame of sculptural installation; "in a work of installation art, the space and the ensemble of elements within it, are regarded in their entirety as a singular entity" (Bishop, 2005, p. 6). My aim with this framing was that it would enable a spatial relationship to be established between the works and the architecture around them. On stepping into this space for the audience, there is necessarily an initiation of a bodily response; the audience physically enters into a designated space, and through doing so is brought into an experiential or physical (embodied) relationship with the work. Here, the participant is more than a pair of disembodied eyes that surveys the work from a distance. Rather, "installation art presupposes an *embodied* viewer whose sense of touch, smell and sound are as heightened as their sense of vision. This insistence on the literal presence of the viewer is arguably the key characteristic of installation art" (p. 6).

The unique architectural features of each space – the restrained 'white cube' of Exeter Phoenix gallery space, the long high-walled corridor of Test Space, and the public space of the Control Room – created further

Figure 71: Installation view, Exeter Phoenix (November 2015)

Figure 72: Installation (detail) Cuboid forms of monitor and casing (2015)

means of framing the works. I considered each context in a formal, aesthetic sense, similar to the presentation of the A4 exegesis (where the 'landscape' layout and font serve as framing devices for the work). All of these spaces can be seen in parallel, therefore, as 'containers' for the artistic practice.

SURFACE/CONTACT: an initial testing ground for the work

This group show at Exeter Phoenix (November 2015) offered a means to test out my initial ideas, particularly regarding scale and combining elements. Here, my aim was to establish a dialogue or *conversation* between the works, so that they could be understood in relation to each other as material echoes – as elements or fragments of a much larger process.

The large two-dimensional 'billboard' print (here measuring 600 x 300 cm) worked as a means of framing the works, relating to the architecture of the site and space of the gallery (as white cube). As one facet of the installation, it functioned both as a kind of backdrop, locating the works, but also because of its scale, it prompted a physical relationship with the audience, alluding to an experience of landscape.

In presenting the sculpture within the cuboid frame of the transparent casing, my aim was to establish a visual rhyme between it and the cuboid form of the monitor, setting up a dialogue between these aspects of the digital object (both as a screen-based entity, looping within the fluid virtual space of the monitor – Hayle's "dream of information" – and the

rendered, static sculptural form). The presentation of the same form as static sculpture and moving image invited the audience to respond to and experience the works physically, but in distinctly different ways.: the floor-based moving-image claiming a static scrutiny; the taller plinth inviting motion around and above the sculpture, mirroring the onscreen flow. Curator Carolyn Black wrote about the exhibition:

> "The works aren't framed, are rarely hung on the walls in lines, they protrude into the room, they make you walk around them. They are not at the same height – they make you work to see them, look behind things, underneath things, through them. In short, they are demanding that you physically perform in the space; you are actively choreographed around it. You become an active agent in the work, you are welcomed into the work, not as a passive viewer but as a collaborator." (Black, 2015)

The casing refers both to a Heideggerian *enframing,* and to the literal frames of the various processes employed. For example, the frame of the screen, or the build canister of the ALM machinery (Figures 47 and 50). I was interested in the recombinant nature of the elements: in the relational and dialogic interaction between the works (in the viewers imagination) as elements in a system; as nodes of a much larger (hidden, invisible) whole or process. This interaction was directly informed by observations and notes made in the studio, when considering the sculptures as a group:

> "I feel like they are having a conversation together that I don't understand. They feel like a body of work – but what? … fragments of a much larger whole – there's an uneasy feeling (or is it just me?) an *Uncanny* feeling … I'm not sure of their relationship to each other – to the wider world – to the source material – they are *so white*" (Notebook, July 2014)

I paid considerable attention to the materials and the quality of surfaces in the installation. The surface of the billboard print and how it adhered to the gallery wall was incredibly important (a formal decision[1]). The reflective black glass echoed the black transparency of the video screen, as well as alluding to other screens, specifically those of smartphones, which are physically absent in the practice but critical to its context (as discussed in Chapter 2). This reflective surface was repeated on top of the matt black plinth displaying the sculptural object, and reflected the large billboard print surface, therefore placing the sculpture both next to and within its pixelate structure.

Finally, I introduced a found object into the installation, a large circular black glass, which I considered as a *Punctum* in the work – a kind of marker or a site of multiplicity; a space for reflection, surface and depth. As an object, it functions as both a two-dimensional reflective surface and a three-dimensional sculpture, and resists being either one or the other. From a distance it has the appearance of a full stop, a punctuation point. As a marker, it is the 'you are here' symbol on the screen of Google Maps; an optical and psychological blind-spot:

> "It's a void isn't it? It frames the different elements… conflates them on its surface – so it's interesting how that operates like that. It has an autonomy, but it also performs – […] *unto itself*." (artist Sophie Warren, peer critique; Appendix 15, p. vi)

[1] Which took a further two days to smooth and correct by hand, after the gallery technician pasted the work badly / blistered.

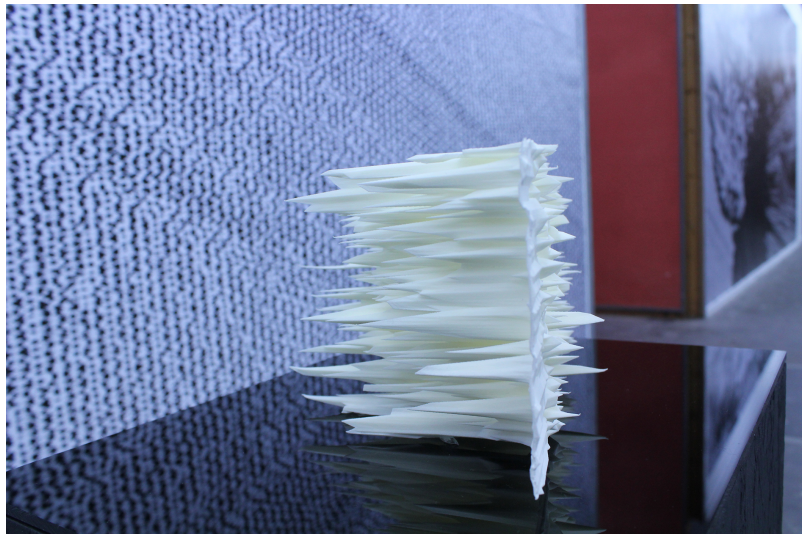


Figure 73: *Zero Landscape* detail (2016) Test Space Spike Island, Bristol

Figure 74: *Zero Landscape* (2016) The Control Room, Bristol

Zero Landscape
Test Space Spike Island and
The Control Room, Redcliffe Bridge, Bristol

Zero Landscape was a solo exhibition, split across two sites in Bristol. Whilst it enabled me to draw on my experience of presenting the work in Exeter, it was important not to simply restage the works in the exact same configuration, but to consider the contexts and spaces anew. Staging the works as installation was more successful here. Using the unique architecture of Test Space, I further developed the physical relationship between the body of the audience members and the work.

Bodies here were (intentionally) implicated by the scale of the large billboard print (here measuring 300 x 1200 cm). Involving the spectator in the physical (visceral) experience of the work was an important element, and in Test Space the architecture denied the possibility of being able to stand back from the print sufficiently to take it in 'as an image' in its entirety. The sheer scale of the piece in relation to the width of the space frustrated any attempt to see it 'at a distance' or as a whole. This prompted responses from the audience:

> Richard –
> "*it forces me to completely change my relationship to it, and my own desire to be able to stand further off and have* my *own [relationship with] the image … for that kind of totalising experience.*" […]
> Solveig –
> *"It works really well as a spatial metaphor for just being completely overwhelmed by data.*"
>
> (extracts from peer critique, January 2016; Appendix 15, p. ix)

Risograph Billboard Print

Whilst it was my intention to physically implicate the body in the installation by way of scale, a second serendipitous implication manifested through my resizing of the image. This enlarged and elongated the stippling effect created through the risograph process. The resulting span of abstract shapes and dots, in combination with the high contrast black and white print, under the overhead fluorescent light, created conflicting patterns and a marked optical, physical response in the audience, similar to the desired effects of Op Art.

> "Much of Op Art relies upon the scanning movement of the eye over the picture surface. This movement can be accelerated and disturbed by making up the surface design from a large number of slightly varied small shapes or lines […] the brain finds itself unable to impose one particular image but offers a number of different solutions at once." (p. 30)

Optical art is a method "concerning the interaction between illusion and picture plane, between understanding and seeing" (Lancaster, p. 28) to become aware that 'Seeing' is a physical process – a process of perceptual understanding as well as the physical action of using the eyes. This process can also be unsettled, or simply made physically palpable in the body of the spectator who then becomes aware of their own body in relation to the work, and of their bodily response to it.

> "Here in Test Space our bodies are implicated in the work – it is impossible to stand back, to get an overview; the image dwarfs us in its expanse, the landscape swallows *us*." (Zero Landscape, Gallery Text, Connor, 2016; Appendix 16)

The difference created between a normative pictorial image, rendered in perspective and able to be viewed at a comfortable distance, and this perceptually uncomfortable and oversized image, could be seen as similar to that between a perspectival view or grid over a landscape as a structured system (*remote-sensing* as a 'God's eye view'), and the *experiential* aspects of being in that environment (having a visceral, multi-sensory response to all the elements that make up an environment; one's physical responses to the cold, to light, the ability to see distance, sense depth, understand one's position and place, one's orientation and sense awareness of danger).

> "instead of the spectator simply looking at the picture as an object, as something that is in a different world to his [sic] own and isolated by the picture frame, he is now encouraged to consider his own relationship and involvement with the work of art. The spectator, therefore […] is involved in a real situation, not an imaginary one. Similarly in Op Art, the spectator is made conscious of the act of perception, the reality of seeing." (Lancaster, 1973, pp. 25-26)[2]

It was important for me to write an accompanying text that referenced these particular decisions and opened out the work for the audience, but didn't *explain* it. I wanted to convey aspects of the process and materials, opening the work up to possible readings, without being prescriptive or didactic.

[2] This quote reminds me of Molesworth's discussion of Rauschenberg's white canvas paintings (1993).

A Conceptual Frame

> "There are works of art that require initiation. This does not mean that they require explanation, special consensus, or any other prescriptive bearing. It does mean that one must discover an *appropriate mode of entry* which is more than informational. This can lead to radical reorientation. (Quasha and Stein, p. 215)

Writers Quasha and Stein (writing here about the video installations of artist Gary Hill) offer a means of navigating the works for the audience that maintains a sense of openness. For my exhibitions in Bristol, the title *Zero Landscape* became a means to conceptually frame the works, taken from the essay by Timothy Morton, *Zero Landscapes in the Time of Hyperobjects* (2011):

> "Hyperobjects are real objects that are massively distributed in time and space. Good examples would be global warming and nuclear radiation. Hyperobjects are so vast, so long lasting, that they defy human time and spatial scales. They wouldn't fit in a landscape painting." (p. 80)

Morton's essay discusses the temporal and spatial scales of phenomena outside the frame of human perception, challenging the preconception of landscape as a framed object of contemplation. He directs our attention to the environment, not merely as a passive backdrop for human endeavour, but rather as cause and driving force of massive transformation – an active agent of future evolutions. Morton similarly addresses visualisation through computer rendering:

> "From painting and cinema, the aesthetic modes of landscape, we move to plots and maps of algorithms in phase space. This is what enormously powerful computers can do now […] we're not seeing it ourselves anymore. Computers see it for us." (p. 87)

This perspective enabled me to establish a new context for the works, linking to themes of landscape, scale and orientation – another means of undoing a cartographic (and instrumental) association of space. They also touched upon my (recent) experience of the remote residency in the Arctic. At the same moment as this shift in magnitude, comes a simultaneous attention to the proximate: "Intimacy will be the new code word" (p. 82), states Morton. The 3D sculptures become orientational figurations – haptic guides for navigation, echoing the carved, tactile maps of the Greenlandic coastlines by Kunit fra Umivik (1884):[3]

> "The objects are, in this sense, orientational nodes […] they are signposts of liminality. […] Objects that are only liminally what they seem to be may lead to some measure of open reflection." (Quasha and Stein, p. 215)

The sculptures hint at aspects of embodiment and machinic intensities that are invisible and outside representational practices of information processing. Through the peer discussion an understanding emerged of these invisible practices having a relation to the body, as parallel acts of experiential processing and 'seizing the body at scale':

> Sophie – "*It's interesting thinking about this in relation to the body – sort of claiming our own body, seizing the body, at scale which is what you're doing.*" (extract from peer critique; Appendix 15, p. v)

[3] These wonderful wooden objects are referenced in Papanek (1995). They were also on display in the recent exhibition *Lines in the Ice: Seeking the Northwest Passage* at the British Library, London (2014).

Experiential aspects such as pain exist on the threshold of embodiment and imagination, and here Jo explicitly references grief as an experiential unknown – as data that somehow needs processing. This encounter, between the audience and the installation, is a corporeal engagement, which enables subtle and multiple aspects of the works to come into play:

> Jo – "*Yes also acknowledging unknowns in the body … it's always very interesting to think if you've hurt yourself, you can process that really easily, but if you're dealing with grief or something like that – it's not something that you can necessarily see* … (Appendix 15, p. vi)

One audience member in particular had a physical, visceral response to the work; its "sensorial image":

Éilis - "*In this space it's that image there that really grabs me [gestures to the large print] … my stomach lurches – I don't know whether I'm being sucked in or spat out* […]" (p. v)

Éilis - *Can I ask about the models? – I'm desperate to touch them. What do they feel like? Are they fragile? Are they tough? Are they sharp?.*" (p. vii)

The "sensorial image" is a term articulated by Lula Wanderley (1993), meaning:

> "something vague, "lived" by the body. Not a sensorial outlining of shape nor some quality of the surface, but something that dilutes the notion of surface and makes the objects to be lived in an "imaginary inwardness of the body" where it finds signification. This is where the frontier is broken between body and object." (Wanderley, quoted from de Zegher, 1996, p. 424)

Figure 75: *Zero Landscape* (detail) (2016) The Control Room, Bristol

Figure 76: The Control Room, Harbourside, Bristol with Full Moon (2016)

A 'Satellite' Installation: The Control Room

Nighttime projections, monitors and lightbox

Exhibiting the work in a white cube gallery frame can be restrictive for many reasons. I also wanted to place the work in a wider social context, where unwitting audience members could glimpse or stumble across something in an unexpected encounter, confounding expectations. 'The Control Room' is a disused industrial site on Bristol Harbourside – an old engine room for its central swing bridge. Lying directly on the commuter path between Temple Meads train station and the city centre, the site is passed by several bus and cycle routes – a potential audience of thousands.

Here, formal aspects of the work – framing and reflection – and themes such as the context of screen media were explored through spatial relationships with aspects of the urban (architecture, environmental cues, 'mediatic atmospheres', and the natural phenomena of darkness and fortuitous moon cycles).

I used video projection, CRT monitors and a light box to present the work, placing it into a social and urban context – into "the atmospheric continuity between lamps and streaming media" (Blom, p. 52). Two identical television monitors offer views into a world framed by the semicircular 'peep holes' reminiscent of the half-closed eye of the Ultrasound scan. The first monitor depicts the interior landscape of the 3D Print machine. The arm sweeps over the surface of the landscape

every twenty seconds, rather like a mechanical operation from a bygone age; we peer into this white expanse, reminiscent of an arctic plain or an incubator. The second television screen, which contains appropriated time-lapse satellite imagery, offers a landscape that expands and contracts with a biological velocity of something being digested and then expelled. Seen together, the two offer perspectives on worlds that are hidden to us, bringing the atmospheric experience of "distant presence".

> "the Control Room … had some sort of phenomenological occurrence going on – which looked like it was scanning a part of the body, or scanning something phenomenological … there was a very strong sense of the body in relation to an exterior-scape or landscape. […] these relationships to the body and these exterior-scapes were particularly resonant and strong with that piece." (artist Sophie Warren, Appendix 15, p. vii)

These screens and the illuminated sculpture shown alongside them bring the Control Room to life, illuminating the whole space like a lamp in the urban fabric. "Lamp works […] delve into the phenomenological minutiae of media perception" (Ina Blom, p. 59).

In walking between the two sites along Bristol's Harbourside, a serendipitous full moon offered a *punctum* in negative, in the fabric of the night sky. "*Over day and night, each turns the other inside out*" (Connor, 2016, Appendix 16).

> "There's something so exciting about it being activated by the darkness particularly in relation to notions of interior landscapes. The extended conversation between the works over two sites has a quality of resonance – prolonging the work like sound, through reflection and vibration." (email correspondence with artist Sophie Warren, 2016,, Appendix 17)

The artworks as material embodiments of the research.

Whilst I made a deliberate decision not to explicitly reference the PhD research questions or themes in the text or information about the show, what I found, through the audiences' comments and peer critique, was that as a result of engaging with the artworks, the (bodies of the) audience engaged with the *material* or substance of the artistic research. This was an illuminating and welcome aspect of the process. As novel articulations of this information, this research data, as *material metaphors,* the works became embodied carriers and transmitters of my research, perceptible through imaginative, intuitive and 'sensorial' means.

> "the experiences and insights that artistic research delivers are embodied in the resulting art practices and products […] their persuasive quality lies in the performative power through which they broaden our aesthetic experience, invite us to unfinished thinking, and prompt us towards a critical perspective on what there is." (Borgdorff, 2010, p. 47)

Chapter 9:
New Contexts: New Materialism

Introduction

This concluding chapter functions as a speculative discussion around issues of materiality, embodiment and information in relation to my practice. Given that the material substance of the work, Nylon 12, is the predominant plastic used at the present time for manufacturing 3D Prints, here I will consider this material in relation to our cultural blind spot – the materiality of information – considering its ideological import for emerging digital practices, specifically those that combine techno-scientific research with bio-printing technologies.

As I acknowledged in Chapter 4, there is a difficulty in the threshold between the digital and the material – an undeniable *surface tension* here. As a more speculative chapter that raises questions around materiality, this chapter will consider the materiality of plastics, from historical, ecological and corporeal perspectives. Firstly as a pollutant, in both extended and interior geographies, and secondly, by considering this in relation to 3D Print technologies, I suggest that in contemporary society, the body encounters *itself* as fabricated.

These speculations lead to rethinking areas around new materialism. As Coole and Frost state in their introduction to *New Materialisms: Ontology, Agency and Politics:*

> "[…] matter has become considerably more elusive (one might even say more immaterial) and complex, suggesting that the ways we understand and interact with nature are in need of a commensurate updating. […] the emergence of pressing ethical and political concerns that accompany the scientific and technological advances predicated on new scientific models of matter, and in particular of living matter […] [and] the significance of complex issues such as climate change, the biotechnological engineering of genetically modified organisms, or the saturation of our intimate and physical lives by digital, wireless and virtual technologies." (Coole and Frost, 2010, p. 5)

By reflecting upon these themes that have arisen through the artistic research – through *poetic praxis* – this Chapter is therefore my attempt at rethinking the ways that we might interact with and understand the implications of such emerging practices.

To revisit the process of making *Untitled_Force:* I took a sample of my blood as the starting point, initiating a series of material transformations; translating this bio-matter through a sequence of digital processes which rendered the data as two-dimensional images and three-dimensional sculptures. The decision to place my blood in the machine was made in order to create a metaphorical relationship (between myself and the machine) based on intimacy. Through doing so the work becomes a dialogue between technology and the presence of (my) female body.

As I discussed in Chapter 6, questions around 3D Print bring these concerns of materiality and virtuality into focus, especially when 3D Print is idealised as an immaterial practice – "imagine an object and it will appear!" (New Scientist, 2000). This promulgated notion of its ability to render all things (instantly) contributes to a perception of the practice as an immaterial process, as the following quotation exemplifies:

> "[…] materials are becoming media. I'm not operating on materials, I'm operating on animations, I'm operating on video, I'm operating on pixels and polygons." (Bitonti, 2014)[1]

Following Haraway (1991)[2] and Hayles (1999), however, the obfuscation of this materiality is an ideological issue, especially when the industry as a whole is still incredibly dependent on material resources, highlighted after a serious explosion at a German factory halted the entire supply of nylon powder to the global automobile industry in March 2012[3], in addition to the inevitable succession of its obsolescent machinery.

---

[1] The co-designer of a 3D Printed dress, modelled by burlesque performer Dita von Teese (Bitonti, 2014).

[2] Haraway states that her *Cyborg Manifesto* "came out of the materialities of instrumentation of organisms and laboratories [and] the various non-humans on the scene" (Gane and Haraway, 2006, p. 136). She goes on to state that Katherine Hayles "situates herself at the right interface – the place where people meet IT apparatuses, where worlds get reconstructed as information. I am in strong alliance with her insistence […] getting at the materialities of information." (p. 140)

[3] "The adoption of 3D printing for more applications requires that designs are created specifically for the material with which they will be produced. This is partly a limitation of technology, as the machines are often only able to use a few specific materials, but this is also an essential requirement that must be

Materialities of information

In her influential text, *How We Became Posthuman: Virtual Bodies in Cybernetics, Literature and Informatics* (1999), Hayles identifies that the historical concepts both of embodiment and the materiality of information are entwined in a way that is highly problematic. The popular notion that we can simply upload consciousness (without the body) into the mainframe (as William Gibson writes, for example) is misguided and clings to a Cartesian duality – that of a mind that is separate from the body. Yet as Anna Munster points out in *Materialising New Media: Embodiment in Information Aesthetics* (2006), this duality still remains unquestioned in contemporary debates on information and materiality. This discourse of information *without a body* is pernicious, however, as it obfuscates the very materiality of its instantiation.

In 2015, questions are finally surfacing regarding the (perceived) materiality of the internet: the databanks and servers of corporate giants Google and Amazon; the super-planned obsolescence of electronic devices, smartphones and computers; the mining of precious metals for building capacitors and transistors in disposable devices; the global movements of toxic waste and rubbish dumps of e-waste.[4] Materiality as *leakage* is starting to seep into debates around information technologies and their global impact, recognising finally that "human life is embedded in a material world of great complexity, one on which we depend for our continued survival" (Hayles, 1999, p. 5).

met if 3D printing is to approach traditional manufacturing in efficiency." (Trocola 2012).

[4] See Jennifer Gabrys, "Digital Rubbish: A Natural History of Electronics" (2013).

"A default white material is used where no material was available"[5]

At the time of writing (2015) the majority of ALM products are made with Nylon 12 (also known as Polyamide 12 or PA 12). This is a plastic ordinarily used in manufacturing household and industrial products (such as cable ties, wire insulation and medical catheters). Nylon 12 is a fine, bleached white nylon powder which, once laser-sintered, is strong and *bio-compatible,* being used for applications in the automotive and aerospace industries, as well as for human prostheses.[6]

From a contemporary perspective, plastics are not a new material. In an advert for Bakelite Plastics from 1943 (some seventy-three years ago) the following claims are made, and distinct echoes of these can be heard in today's claims for 3D Printing:

> "They are any shape you choose. They are any colour you want them to be. Sometimes they take simple forms – the door handle, the electric light switch, the bottle cap. Sometimes they

[5] *MeshLab* error message (2012)

[6] Nylon 12 as a powder is also a material included in many cosmetic-industry products, especially anti-ageing moisturisers, which can contain up to 35% plastic. See p. 128 later in this chapter.

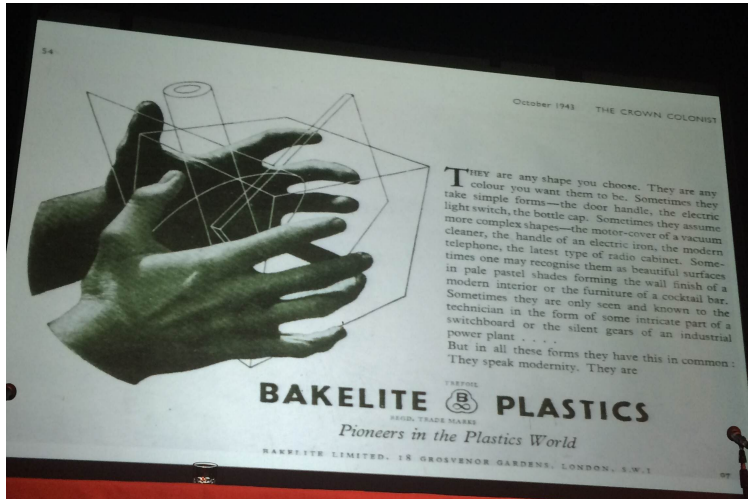


Figure 77: Bakelite Plastics Advertisement (1943) *The Crown Colonist.* October (p. 54) From presentation by Jo Stockham, *ReDefining Print* Exeter (November 2015). Photo: iPhone 5 Smartphone

Figure 78: "*News about Nylon: it all started with a stocking*". Advertisement for Nylon Stockings, Du Pont (Sickels, 2004, p. 93)

> assume more complex shapes – the motor-cover of a vacuum cleaner, the handle of an electric iron, the modern telephone, the latest type of radio cabinet. Sometimes one may recognise them as *beautiful* surfaces […] Sometimes they are only seen and known to the technician in the form of some intricate part of a switchboard or the silent gears of an industrial power plant […] But in all these forms they have this in common: They speak modernity. They are *Bakelite Plastics: Pioneers in the Plastics World.*" (Bakelite Plastics, October 1943)

This advertisement establishes these plastic objects as novel and desirable – as "beautiful' objects.[7] As much as 3D print is a new technological process, it is vital that it can be seen within the history of plastics as a whole, as yet another means of developing, manufacturing and *marketing* plastic objects throughout their history. Nylon 6 (first patented by Wallace Carrothers in the United States on February 16 1937) was launched as a commercial product by DuPont the following year, with their range of plastic toothbrushes. Later becoming more desirable – sensuous, even) – with the targeted launch of ladies' Nylon stockings in 1940.[8] Twenty years later Roland Barthes also sang its praises:

> "The hierarchy of substances is abolished: a single one replaces them all: the whole world can be plasticized, and even life itself since, we are told, they are beginning to make plastic aortas." (Barthes, 1957, p. 111)

[7] We are reminded of Lyotard's idea of the "too beautiful" here (1982). [Chapter 6]

[8] Launched on "N-day" after a targeted, extended marketing campaign (Sickels, 2004, pp. 93-94).

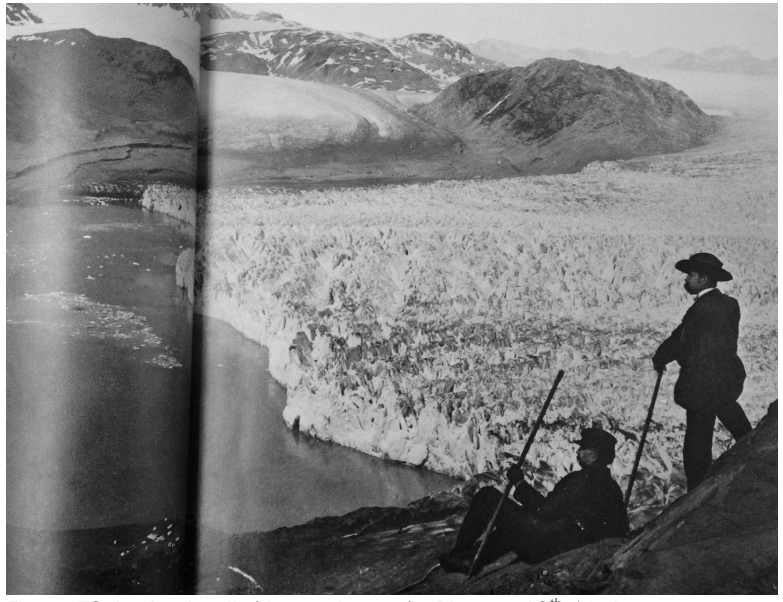


Figure 79: La Roche, F. (date unknown) "Pioneer 19th Alaskan explorers T. J. Richardson and Frank La Roche (standing) look down, from 1,800ft, on Muir Glacier." (*The Alaskan Experience,* p. 31)

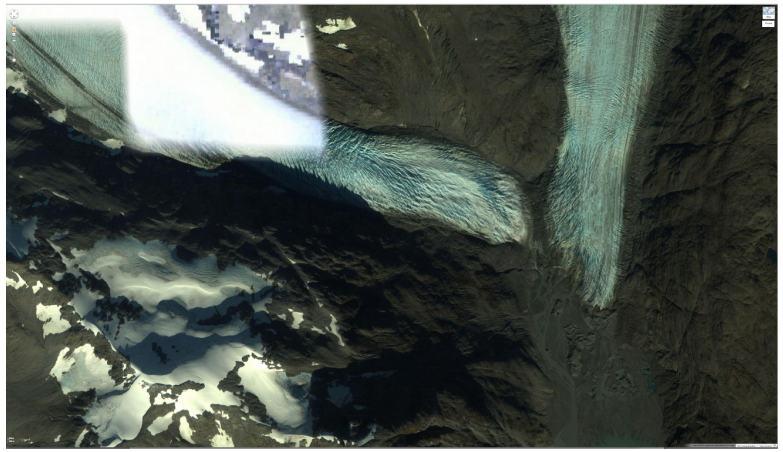


Figure 80: Google Maps satellite view over Muir Glacier (2015) Screenshot

Seen from this historical perspective, much of the commotion about 3D printed objects is exactly the same as that generated over the last century about plastic as a material.[9] From the vantage point of the 21st Century, however, Barthes' idea that "the whole world can be plasticized" looks rather less appealing. "Humans have made enough plastic since the second world war to coat the Earth entirely in cling film", states Robin McKie (*The Observer*, January 2016) and many questions abound regarding the environmental impact of these 3D printed plastic parts, including their inability to biodegrade:

> "3D Printing is an artisan practice for an oligarchy of enthusiastic designers who alongside marketing gurus are extolling the virtues of 'organic-looking shapes' […] it is likely that most will simply clutter up our rubbish dumps and precipitate our plastic marine continents as indestructible rubbish icebergs." (Armstrong, 2014)

These are all factors that feature prominently in this 'new revolution' of 3D Printmaking. As Rachel Armstrong writes, "Despite its growling list of glowing attributes, 3D Printing is not a revolution in making until it addresses the fundamental issue of 21st Century materiality" (2014). Questions around 3D Print once again bring these concerns around materiality and virtuality into focus, highlighting, for example, the ecological impact of manifold 3D plastic parts in the environment:

> "Plastics are the emblematic material of the "throwaway society". In this sense, plastics are both disposable and mobile, because once they are discarded, they inevitably circulate through

[9] A Media Archaeological analysis of 3D print technology is beyond the scope of this essay, but is sorely needed.

extended geographies." (Gabrys, 2013, p. 14)

This 19th Century photograph (Figure 79) documents two explorers in their journey in 'discovery of' the glacial Arctic landscape of Alaska. At the time the photograph was taken Muir Glacier rose eighty-one metres above the water and was nearly two miles wide. It has since receded and no longer reaches the sea. Today we can read the photograph in a similar way to "*Wanderer above the Sea of Fog",* the oil painting by Romantic artist Caspar David Friedrich, in which the protagonist looks out over a sublime landscape. Once a metaphor for the unknown future – the wanderer's position overlooking the precipice, contemplating the vast expanse and their relative scale within it – the painting no longer suggests such mastery over landscape, but rather the *insignificance* of the individual within it.

If we shift our view to the 21st Century, courtesy of Google's mapping software and its wealth of satellite data, we can see the view over Muir Glacier from our tiny smartphone screens, which reveal that the glacier has substantially diminished. In the 21st Century, La Roche's self-portrait (Figure 79) becomes that of our onlookers witnessing the ecological impact of 3D Print and plastics in the ocean, where an indestructible plastic terrain assumes the scale of glaciers. But can we step outside of human temporality and envisage what these objects will be doing in the hundreds of years that it takes Nylon 12 to break down? Robert MacFarlane writes:

> "Plastics in particular are being taken as a key marker for the Anthropocene […] Because plastics are inert and difficult to degrade, some of this plastic material will find its way into the strata record. Among the future fossils of the Anthropocene, might be the trace forms not only of megafauna and nano-planktons, but also shampoo bottles and deodorant caps. […] What will survive of us is plastic." (2016)

As a pollutant, these plastics invisibly weave their way through and around extended as well as *interior* geographies. As a material, Nylon 12 may be used to fabricate the bottle, but it is also one of the staple ingredients of its contents. Used widely in the cosmetics industry, particularly in the manufacture of anti-ageing balms and moisturisers, Nylon 12 can constitute up to 35% of the product itself:

> "In cosmetics and personal care products, the Nylon ingredients are used in the formulation of body and hand preparations, eye makeup, mascara, nail polish, and skin fresheners. Nylon-12 and Nylon-66 can also be found in bath products, deodorants, face makeup, indoor tanning preparations, lipsticks, moisturizers, night skin care products, paste masks, skin care products and suntan products." (Personal Care Products Council, 2013)

In cosmetic formulations, these nylon ingredients "function primarily as bulking and opacifying agents" (Burnett et al.., 2014, p. 47)[10], but "additional functions may include absorbents and film formers" (p. 51). "Nylon 12 has the most reported uses in cosmetic and personal care products", and "is reported to be used at a range of maximum

[10] Opacifying agents are substances that reduce the clear or transparent appearance of cosmetic products. Some opacifying agents are used in skin make-up for hiding blemishes. (Opacifying agent definition 2013)

concentrations of 0.001% to 35%, with 35% reported in face powder formulations" (p. 51). Additionally, this synthetic ingredient is

> "used in cosmetic sprays (such as perfumes) and face powders and could possibly be inhaled. These ingredients are reportedly used at concentrations up to 8% in spray products and up to 35% in face powder products." (p. 51)

What is alarming, given their prevalence in such creams, lotions and powders designed to have such intimate close contact with the skin (see for example *Olay Regenerist Micro-Sculpting Cream Moisturiser,* Olay 2016), is that "the nylon ingredients in this safety assessment are not restricted from use in anyway under the rules governing cosmetic products in the European Union" (p. 57) Nylon 12 is "approved by the FDA as indirect food additives as polymers used for food contact surfaces" (p. 57). Yet, through Animal Testing, the following grim statistics can be deduced:

> "The acute oral LD [Lethal Dose] for Nylon 12 was reported to be 1g/kg in rats, mice, guinea pigs and rabbits. In cats, the acute oral LD for Nylon 12 was about 0.25mg/kg." (p. 57)

- How does the body re-encounter or re-engage with this material, this fabric?

Here, then, in reconsidering my final Research Question, is one way in which the body re-encounters this fabric*:* the body becomes *plasticised*. Jonathan Crary writes:

> "there are numerous pressures for individuals to reimagine and refigure themselves as being of the same *consistency* and values as the dematerialised commodities and social connections in which they are immersed so extensively. Reification has proceeded to the point where the individual has to invent a self-understanding that optimizes or facilitates their participation in digital milieus and speeds […] emulation and identification with the shifting and intangible events and processes with which one becomes technologically engaged." (2013, pp. 99-100)

Crary's work reveals yet another example of the interlacing of technology with bodies. To flip this over conceptually, we can ask the question of what has happened to the body, to embodiment, in this dynamic? My artistic research also points to a broader context, that "*bodies* have become understood as *fabrications*, as made, not born" (Shildrick, 1997, quoted in Kent, 2012, p. xiv).

Other Processes of Fabrication in the Lab

With the 3D printed foetus these bodies now start to be fabricated before they are born, within the womb. Mehaffy writes that the "sonographic fetus is in many ways the ultimate cyborg in that it is 'created' in a space of virtuality that straddles the conventional boundary between an organic body and a digital text" (Mehaffy, 2000, p. 181) Using this foetal scanning technology, this sonographic cyborg now becomes three-dimensional using contemporary 3D Print technology. Scientists, rendering the data from 4D ultrasound scans, are building 3D models of the foetus. The rationale provided for this activity is that blind mothers are now able to feel their unborn babies in their hands, despite the fact that they're already holding them in their bodies (Visual News 2015).

Figure 81: *3D Printed Foetus* (2015) from 3D Print.com (January 2015)

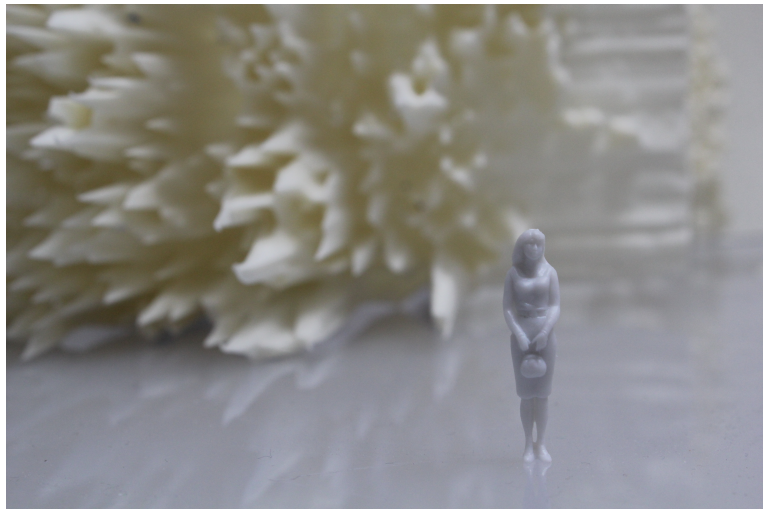


Figure 82: Studio tests: *Fragment no. 4* with scale model figure (May 2015)

This practice raises multiple questions over the legitimacy and the desire to not only visualise, but *materialise* these embodied developments, as discussed in the powerful essay by Rosalind Pollack Petchetsky, *Fetal Images: The Power of Visual Culture in the Politics of Reproduction* (1987). When these objects move from the realm of medical evidence to that of cultural representation, we see that the process embeds ultrasound imaging of pregnancy into a 3D object. This appearance, as both a medical and cultural document or novelty, both obscures and reinforces a coded set of messages that work as political signs and moral injunction (Petchetsky, p. 267).

However, the 3D printed foetus as novelty object obscures a parallel lab practice where 3D printing reconvenes with embodiment, with bio-matter, with stem cells. In 2013, researchers from Heriot-Watt University in Edinburgh in partnership with Roslin Cellab, a leading stem cell technology company, created a cell printer that "spits out living embryonic stem cells" (3D Printing Progress, 2015). This printer is capable of printing uniform-size droplets of cells, yet is gentle enough to keep the cells alive and maintain their ability to develop into different cell types (Live Science 2015).

This print method, designed for use within Regenerative medicine, will be adapted for tissue engineering and stem cell research. Tissue Engineering and Stem Cell research are two approaches to Regenerative medicine, whose multiple claims are to prolong life and address the problems of ageing bodies. Tissue Engineering (TE) is the development of a new type

of implant, "that combines synthetic materials with 'living human cells'." TE can be seen as an "upgraded version of earlier biomedical technologies, but can be seen as going beyond the mechanistic approach to repair and being 'more concerned with the genesis of form – *organogenesis*[11]" (Kent, 2012, p. xiii). Stem Cell research is dependent upon the use of aborted fetal tissue, and the expanding "fetal-tissue economy" (Kent, p. xi). The print method has been developed in order to make 3D human tissues for testing new drugs, to grow organs, and to print cells directly inside the body. These are the normative assumptions underpinning the innovation and regulation of new tissue and cell-based therapies and 3D tissue-engineered constructs.

This more unnerving work, now emerging on the borders of clinical, medical research and embodiment, is on this threshold between the digital, corporeal, and biological construct, facilitating the "emulation and identification with the shifting and intangible events and processes with which one becomes technologically engaged" (Crary, 2013, p. 100). Here, "the saturation of our intimate and physical lives by digital, wireless and virtual technologies" becomes physically lived and embodied (Coole and Frost, 2010, p. 5).

[11] Meaning: "the production and development of the organs of an animal or plant". *Organogenesis* is also a company, and "a commercial leader in regenerative medicine, focused in the areas of bio-active wound healing and soft tissue regeneration" (Organogenesis 2016).

This fluid, threshold space is also the focus of my research, pinpointed through my Research Questions. Whilst in flux, this space can be incredibly productive and generative (living, in fact), yet can equally become instrumentally programmed, policed and politicised at any given moment. Here we uncover the paradoxical reality that despite such obfuscation, materiality or *bodies* in techno-science and the global bio-economy have *never been* quite so vitally important. As Kent reminds us, "women are more heavily implicated within the emerging bioeconomy as donors, as many of the technologies being developed rely on the procurement of reproductive tissues" (p. xiii).

Where Haraway claims that "communications technologies and biotech are the crucial tools recrafting our bodies" (p. 164), in the 21st Century I shall posit a third, similarly crucial tool: 3D Print technology. "*At its most intimate, the abolition of frontiers renders my body up as cells and tissue, vulnerable to manifold incursions*" (Chadwick, 1989, p. 97).

The instrumental use of this fabrication process, as a techno-scientific modelling tool, borders the worlds of medicine, engineering, military and synthetic biology, crossing the divide between art and science and exposing some of the slippages in the spaces between the digital and the material. At the same time, through a meditation upon this approach, through my artistic research – *poetic praxis* – it becomes possible to reveal where points between the natural or biological become solid, in their proximity to the digital material.

[BLANK PAGE]

Conclusion:

This PhD research project has discussed a series of artworks, collectively named as *Untitled_Force* (2011-2015). Taking a sample of my blood as the starting point for the research practice, I translated this biomaterial through a series of digital technical processes, namely those of Atomic Force Microscopy (AFM) and Additive Layer Manufacture (3D Printing). I used these processes to digitise the bio-matter through a non-optical scanning process into topographical data, printing these mediated forms as two-dimensional images and three-dimensional sculptures. Through doing so my intention was to make a space for data to meet the biological; locating this space as the ground or territory for the artistic research.

In developing a body of work that explores an intimate relationship between my blood and the machine through my methodology of *poetic praxis*, I have considered how the materiality of my body is translated; becoming dispersed amongst the non-representational "froth of code", and then fabricated through techno-scientific processes.

My Research Questions were addressed through my methodology of artistic research, which I have named *poetic praxis*. These questions asked:

- How does data 'meet' the biological or natural?
- At what points does the digital become material?
- What happens in this space: the surface tension between the digital and the material?
- How does the body re-encounter or re-engage with this material, this fabric?

Whilst at the start of the research project these questions first appeared rather nebulous or opaque, what I discovered through undertaking the enquiry is that my research questions articulated a valuable, threshold space that is itself incredibly generative. This initial ambiguity in fact reflects the complexity of my area of study – a space of multiplicity, both abstract and invisible, yet fertile and palpable. I will now address each of these questions individually.

- How does data 'meet' the biological or natural?

At the outset, my research considered Atomic Force Microscopy as one techno-scientific practice in which data 'meets' the biological or natural. This is a technology that serves both medical and techno-industrial processes, aiding the further miniaturisation of devices such as the smartphone, and operating in a biomedical field. As such, the AFM is a technology whose instrumental use spans the biotechnological field of my research. Through my methodology of *poetic praxis,* I reimagined or reconsidered this relationship between my blood and the probe as a haptic and material encounter between my body and the machine. To cite Laura Marks, this graze of the haptic enables the "wetness of the encounter" to be revealed (2002, p. x). Revitalised through a process of mutual touch(ing), then, this instrumental process – this 'meeting' of data and the biological – is reframed as a relationship of *intimate contact*.

The documentation of this event, as both digital image and topographical schematic, were reimagined as "poetic debris" (La Frenais, p. 2), and thus removed from their scientific context of *Spintronics* data-sets. Re-contextualised within contemporary contexts of remote-sensing and satellite images (Google's mapping software on smartphones and militarised targets), the two-dimensional image of *Untitled_Force* suggests and alludes to the concept of interior geography or landscape.

- At what points does the digital become material?

Led by the practice – the translation of the digital artefacts into 3D-data modelling software and industrial practices of fabrication – my second question guided this stage of the research. One of the key emerging sites where the digital becomes materialised (or rendered), is through the techno-scientific practice of 3D Printing (or ALM). Working with the Centre for Additive Layer Manufacture (CALM) in Exeter University's engineering labs, I explored this process by attempting to render this digital file.

As an instrumentalised process, this was unsuccessful: the machines and engineers were unable to fulfil my initial request. However, this 'failure' highlighted the current claims made for 3D Printing as both instant and 'friction-free', as well as its limitations within techno-scientific lab-practice; leading to critical reflection upon 3D Print as a material practice, including its relation to broader cultural and historical contexts.

- What happens in this space: the surface tension between the digital and the material?

My third question lay deep at the heart of the research enquiry and was a testing area, with many difficulties. What I discovered through the research is that this space, the surface tension between the digital and the material, is a liminal space; it is a threshold between the natural, biological and technological. It was through addressing this third Research Question that I came to the following conclusions about the space *between* the digital and the material as a threshold space:

As a technologised space, it is both a space of industry – programmed and governed by instrumental technics – yet also retains the capacity to be a poetic space, leading out onto the open (Heidegger, 1977) or the sublime (Lyotard 1982).

As a border space *between* these areas of the biological, natural and technological, it is a policed and patrolled space and thus a political space (especially with regard to (women's) bodies), which Haraway figures as the cyborg (1991).

As a surface, it is a material space – it can be made concrete in form, through lab practices such as 3D Printing. However, through my research I maintain that this should not be restricted to the instrumental use of such practices, but should also allow for indeterminacy, the art of the open, through *poetic praxis*.

As the obfuscation of the materiality of informatics is an ideological issue (Hayles, 1998), this space is an ideological space, referring not only to the materiality of information, but the materiality of bodies in the lab.

As a space of *potential*, this can be a space for the unknown and the indeterminate, but also a space of Otherness, containing that which we do not understand (Solaris), or which we are afraid of (the *abject*).

As a speculative and provocative space, it is subject to a great deal of hypothetical theory, (science) fiction, and investment. This leaves it open to new metaphors (the subject of this enquiry) but also one that can be greatly contested in the converging fields of art and science.

Finally, any or all of these aspects become activated through an event, in which facets crystallise into a particular form or material. It is therefore truly a generative and performative space of potential.

- How does the body re-encounter or re-engage with this material, this fabric?

To conclude, my final question can be addressed in two ways. This material fabric can be understood as the artworks (the outcomes of the *poetic praxis*): material sculptures fabricated in Nylon 12 (alongside the large-scale print works and smaller giclée). As fabricated objects they are embodiments of the research enquiry. I presented them in reconfigured sculptural installations so that they could be read and understood by the body (of the audience) physically and sensorially; as physical, uncanny objects they produce affect, or a physical sensorial response. As material metaphors and embodiments of the research, they can be read as double-indexical sculptures that articulate a relationship of contact between the bio-matter and the machinic, in an *intimate relation*.

However, this PhD enquiry also aims to "to articulate the connectedness of art to who we are and where we stand" (Borgdorff, 2010, p. 57). These encounters and processes can therefore be extrapolated further, to infer new relationships of *encounter* between contemporary bodies in the world, and also future bodies – encounters with not only Nylon 12 but other lab-based "cultural-material practices" (Haraway, 2006, p. 138) of techno-scientific research.

These bodies re-encounter this materiality through the process of fabrication – bodies themselves become *fabricated*.

Contribution to knowledge

Through my PhD research, I have developed a methodology – *poetic praxis*. Through making a series of artworks, *Untitled_Force,* I have demonstrated how *poetic praxis* can be developed as an alternative methodological approach to 3D Print-making: *3D Print as Poetic Praxis.*

Contribution to new understanding

My artistic research has contributed to new understandings, both in the techno-scientific engineering lab and in the space of the art gallery. Firstly, in working on the fabrication of the artworks, James Bradbury stated that through the very practice of making the works, my research had contributed to new realisations about the process of Additive Layer Manufacture (or 3D Print):

> "I'm excited about working more with the creative industry to try to challenge this technology and have an influence on where it can go, and your project is a perfect example of this." (Bradbury, p. xv)

Revealing the materiality embodied in artworks, Nylon 12 and its unforeseen dimension in relation to the body (Richard Broomhall):

> "I must admit I'd never thought of cosmetics or suntan lotion like that. It made me really reflect … You're looking at a solid object and then thinking, well how would I actually absorb *that* through my skin? … I found *that* was a really interesting threshold." (Broomhall, p. iii)

One unexpected (but no less important) aspect arising out of my activities is a realisation of the renewed significance of Helen Chadwick,

whose vital work presaged many biotechnological lab practices and opened ethical and discursive avenues of thought. These now have such vital importance in contemporary techno-scientific practices currently being developed, tested and instrumentalised; practices that probe and manipulate life both at the cellular level and the nanoscale.

Meaning and Purpose of the Research

Under current instrumental paradigms, the aim is for there to be no gap in between the material and the digital – for this relationship (between the real and the virtual) to be friction-free. The engineer Bitonti postures:

> "[…] the separation between what you can simulate and what you can physically model is gone […] I can make anything I can draw, and I can make something behave any way I can imagine it to behave – the gap just closes everyday [and] it gets easier and easier to overcome what was science fiction." (Bitonti, 2014)

However, as my research has shown, there are significant difficulties with this *idealised* understanding – discrepancies in *mastering* this instrumental *techné*. These difficulties reveal themselves at the heart of my research project.

Having developed my methodology of *poetic praxis* and applied it to the technologies and practices of 3D Print, I do believe that this research could also have value outside of the specific field of this research enquiry, particularly alongside fields of scientific research. As Borgdorff reminds us, the value of artistic research lies

> "[…] in its ability to offer the very reflection on who we are and where we stand that is obscured from sight by the discursive and conceptual procedures of scientific rationality." (Borgdorff, 2010, p. 50)

Poetic praxis in particular, is therefore a vital contribution to understanding where we are in the world, revealing and articulating ways of engaging with technologies. We change the world by changing the way that we make it visible.

In the field of biotech practices the instrumental paradigm is applied to lab-based practices, including 3D printing with stem cells and Synthetic Biology. This relationship models life itself as something that can be manipulated (enframed within) an engineering and instrumental paradigm. Informatics is a material practice, and techno-scientific practices have material impacts of great import. My fear is that these material lab-practices which *frame* the body as bio-material for synthetic fabrication will start to dismiss the experiential, intuitive, phenomenological body as only a *bi-product* of that instrumental approach. It is in this area, this vital and contemporary context, in which my methodology of *poetic praxis* can have real value.

> "Artistic research is more directed at a not-knowing, or a not-yet-knowing. It creates room for that which is unthought, that which is unexpected – the idea that all things could be different. Especially pertinent to artistic research is the realisation that we do not yet know what we don't know. Art invites us and allows us to linger at the frontier of what there is, and it gives us an outlook on what might be." Henk Borgdorff (2010, p. 61)

Future applications for the research within the contexts of academia and contemporary arts practice.

Bodily Matters conference, July 2016

I shall be presenting my research at the conference *BodilyMatters: Human Biomatter in Art: Materials / Aesthetics / Ethics,* held at University College London. Here, my artistic research will be situated in relation to other "biomaterial" artworks.

> "[…] little scholarly attention has been paid to modern and contemporary art practices that use the raw material of the human body itself in the production of artworks. This interdisciplinary conference seeks to address this by examining the creative manipulation and use of human biological matter in the production of artworks, their display and critical reception." (Bodily Matters 2016)

Artist in Residence, Bristol University
Dept. of Geographical Science with BrisSynBio Research Lab

I am currently in discussion with academics at the University of Bristol, regarding a position of Artist in Residence (2016) within the School of Geographical Science. This residency would uniquely offer a significant opportunity to engage with elements of biomedical research. Dr. Maria Fannin (Senior Lecturer, Human Geography) undertakes collaborative research with Professor Julie Kent (Synthetic Biology Research Centre) into placental relations and the spatial imaginaries that inform scientific and philosophical understandings of these activities. As such, engaging with these academics as resident artist would also enable me to engage with the current research being generated at Bristol's Synthetic Biology Research Centre (BrisSynBio), where Prof. Kent leads on responsible research and innovation, particularly in the key research area of bio-engineering, feminist bio-ethics and synthetic blood (BrisSynBio 2016).

My intention with the residency would be to investigate, explore and respond to further ethical and philosophical issues surrounding Synthetic Biology, through my developing methodology of artistic research, *poetic praxis*.[1]

[1] At the time of writing (2016) we have made an application to the Leverhulme Trust for funding to support this position.

Bibliography

3D Print Show (2013) *3D Print Show London Official Programme,* 7-9 November 2013. Unpublished.

3D Print Show (2012-15) *3D Print Show:* Global Trade Fair [online] St Albans. Available from http://3dprintshow.com. [Accessed 5 December 2015]

3D Printed Foetus (2015) [image] *Estonian Company Offers To 3D Print A Portion of Your Unborn Child.* 29 January 2015 New York: 3D Print.com [online] Available from http://3dprint.com/40921/3d-print-your-unborn-child/ [Accessed 1 June 2015]

3D Printing Progress (2015) *Printed human organs for testing and transplantation* [online] Available from http://www.3dprintingprogress.com/articles/7453/printed-human-organs-for-testing-and-transplantation [Accessed 22 September 2015]

3D Systems. (2012) *Sinterstation promotional video.* [online] Rock Hill, SC. Available from https://www.youtube.com/watch?v=lC0uVO_uT0s [Accessed 18 October 2012]

Airbus (2016) *Airbus: Group & Vision: what we stand for* [online] London. Available from http://www.airbusgroup.com/int/en/group-vision.html [Accessed 11 January 2016]

Allen, J. (2010) *That Eye, The Sky: How we're getting used to the view from above.* [online] London: Frieze. Available from http://www.frieze.com/issue/print_article/that_eye_the_sky/ [Accessed 26 April 2013]

American Society for Testing and Materials (2012) Definition of Additive Layer Manufacture. *Centre for Additive Layer Manufacture CALM Open day.* (2012) Exeter University, 22 June 2012

Anderson, C. (2010) *In the Next Industrial Revolution, Atoms Are The New Bits.* [online] New York: Wired. Available from http://www.wired.com/2010/01/ff_newrevolution [Accessed 18 December 2012]

Anthony, A. (2012) *Makers: The New Industrial Revolution by Chris Anderson – Review.* [online] London: The Observer. Available from http://www.guardian.co.uk/books/2012/nov/04/chris-anderson-makers-revolution-review [Accessed 16 December 2012]

Armstrong, R. (2014) *3D Printing Will Destroy The World Unless it Tackles the Issue of Materiality* [online] London: The Architectural Review. Available from http://www.architectural-review.com/home/products/3d-printing-will-destroy-the-world/8658346.article [Accessed 4 February 2014]

Baird, J. C. and Noma, E (1978) *Fundamentals of Scaling and Psychophysics* [online] (John Wiley & Sons) Available from http://www.unileipzig.de/~isp/isp/history/explanation.htm [Accessed 26 April 2013]

Bakelite Plastics (1943) Advertisement. *The Crown Colonist.* October 1943. p. 54. From Stockham, J. [conference paper] *ReDefining Print* Exeter. November 2015.

Ballard, J. G. (1974) *Crash*. Introduction to the French Edition. London: Flamingo pp. 5-9

Barad, K. (2007) *Meeting the Universe Halfway: Quantum Physics and the Entanglement of Matter and Meaning.* Durham, NC: Duke University Press

Barone, T. and Eisner, E. (2011) *Arts Based Research*. London: Sage

Berry, D. M., Dieter, M. Gottlieb, B. and Voropai, L. (2013) "Imaginary Museums, Computationality & the New Aesthetic" from *Transmediale Back When Pluto Was A Planet.* [Catalogue] Gansing, K. et al. (ed.) pp. 1- 41

Betterton, R. (1996) *An Intimate Distance: Women, Artists and the Body.* London: Routledge

Bhatta, B. (2011) *Remote Sensing and GIS*. 2nd Ed. India: Oxford University Press.

Biggs, M. A. (2004) "Learning from Experience: approaches to the experiential component of practice-based research" in: *Forskning, Reflektion, Utveckling*. Stockholm: Vetenskapsrådet, pp. 6-21. [online] Available from http://uhra.herts.ac.uk/bitstream/handle/2299/7464/901028.pdf?sequence=1 [Accessed 2 December 2015]

Bioforme light shade (2014) [online] Available from http://3dprintingindustry.com/wp-content/gallery/3d-printed-lampshades/lamp6.jpg [Accessed 22 December 2015]

Bishop, C. (2005) *Installation Art.* London: Tate.

Bishop, R. (2015) "Smart Dust and Remote Sensing: The Political Subject in Autonomous Systems" in *Cultural Politics*, Volume 11, Issue 1. Duke University Press.

Bitonti, F. (2014) Interview with Francis Bitonti,. *3D-printed dress for Dita Von Teese by Michael Schmidt and Francis* Bitonti. [online] London. Available from http://www.dezeen.com/2014/02/14/moviefrancis-bitonti-dita-von-teese-3d-printed-dress/ [Accessed 18 December 2014]

Black, C. (2015) *Redefining Print*: *the writer/observer experience.* [online] Available from http://www.vasw.org.uk/news/redefining-print-the-writer-observer-experience.php [Accessed 19 December 2015]

Blender (2012) [Software] v. 2.63 (27 April 2012) Available from https://www.blender.org/ [Accessed 16 May 2012]

Blom, I. (2006) "Visual/TeleVisual: Introductory Comments to Another History of Video Art" from *The Expanded Eye: Stalking the Unseen*. Ostfildern: Hatje Cantz pp. 49-60

Bodily Matters (2016) *Bodily Matters: Human Biomatter in Art Materials / Aesthetics / Ethics.* [online] London: UCL Available from http://thanatocorpus.com/bodily-matters/ [Accessed 16 March 2016]

Borgdorff, H. (2010) "The Production of Knowledge in Artistic Research" from *The Routledge Companion to Research in the Arts.* Biggs, M. and Karlsson, H. (eds.) London: Routledge. pp. 44-63

Borgdorff, H. (2012) "Boundary Work - An Interview with Michael Schwab" from *Intellectual Birdhouse: Artistic Practice as Research.* Bauer, U. M. (ed.) London: Koenig pp. 117-123

Brown, N. (2004) "Needle on the Real: Technoscience and Poetry at the Limits of Fabrication" in *Nanoculture: Implications of the New Technoscience*. Hayles, N. K. (ed.) Bristol: Intellect. pp. 173-190.

Bridle, J. (2011- ongoing) *New Aesthetic.* [online] London. Available from http://new-aesthetic.tumblr.com/ [Accessed 5 December 2015]

BrisSynBio (2016) University of Bristol, Synthetic Biology Research Centre, Ethics and Responsible Research and Innovation. [online] Available from http://www.bristol.ac.uk/brissynbio/responsible-research-and-innovation/ [Accessed 2 April 2016]

Buck, L. (1996) *Obituary: Helen Chadwick.* London: Independent. [online] 18 March 1996. Available from http://www.independent.co.uk/news/people/obituaryhelen-chadwick-1342742.html [Accessed 24 July 2014]

Burnett, C., Heldreth, B., Bergfeld, W., Belsito, D., Hill, R., Klaassen, C., Liebler, D., Marks Jr., J., Shank, R., Slaga, T., Snyder, P., and Andersen, F. A. (2014) "Safety Assessment of Nylon as used in Cosmetics" from *International Journal of Toxicology.* Vol. 33 (Supplement 4) 47-60 S. Sage [online] CIR Ingredient Status Report. Available from http://online.personalcarecouncil.org/jsp/CIRList.jsp?id=5005 [Accessed 6 December 2015]

Burnett, R. (2008) "Learning, Education, and the Arts in a Digital World", from *Educating Artists for the Future: Learning at the Intersections of Art, Science, Technology and Culture.* Alexenberg, M. L. (ed.) Bristol: Intellect

Burnham, J. (1968) *Beyond Modern Sculpture: The Effects of Science and Technology on the Sculpture of This Century*. London: Allen Lane/Penguin Press

Castells, M. (1996) *The Rise of the Network Society*. Oxford: Blackwell

Chadwick, H. (1988-89) *Viral Landscapes* [Framed C-print photographs]. From "Stilled Lives: Helen Chadwick" (1996) Edinburgh: Portfolio Collection: National Museums Liverpool, Walker Art Gallery

Chadwick, H. (1989) *Enfleshings.* New York: Aperture.

Chadwick, H. (1994) *Interview with Mark Haworth-Booth* [online] London: British Library Sound Archive: Oral History of British Photography. Available at https://sounds.bl.uk/Arts-literature-and-performance/Art-photography-and-architecture/021M-C0459X0053XX-0100V0 [Accessed 20 December 2015]

Chadwick, H. (1996) *Nebula* (Detail) [Framed photograph] From "Stilled Lives: Helen Chadwick" (1996) Edinburgh: Portfolio

The Art Of Helen Chadwick (2004) [documentary, DVD], 50 mins. London: Illuminations.

Chadwick, H. (2016) *Notebook on Viral Landscapes: Technical Notes on the making of Viral Landscapes* [online] Leeds: Henry Moore Institute https://www.henry-moore.org/hmi/archive/turning-the-pages--helen-chadwick-notebooks [Accessed 20 December 2015]

Chalmers, G. (1996) *Stilled Lives: Helen Chadwick.* Edinburgh: Portfolio

Chambers Dictionary (2014) *Blood*. Chambers Harrap Publishers. 13th edition. [App] WordWebSoftware. [Accessed 16 January 2016]

Cloninger, C. (2012) *Manifesto For A Theory Of The 'New Aesthetic'.* London: MetaMute. . [online] Available from http://www.metamute.org/editorial/articles/manifesto-theory-new-aesthetic [Accessed 28 April 2013]

Connor, K. (2013) "Translating Practice", from *Journal of Writing in Creative Practice.* Volume 6, Number 1. Bristol: Intellect. pp. 127-133

Coole, D. and Frost, S. (eds.) (2010) *New Materialisms: Ontology, Agency and Politics.* London: Duke University Press

Crary, J. (2013) *247: Late Capitalism and the Ends of Sleep*. London: Verso

Cubitt, S. (1998) *Digital Aesthetics.* London: Sage.

Cubitt S. (2014) *The Practice of Light.* Cambridge MA: MIT.

da Costa, B. and Kavita, P. (2008) *Tactical Biopolitics: Art, Activism and Technoscience.* Cambridge: MIT.

de Vries, I. (2009) "The vanishing points of mobile communication" from *Digital Material: Tracing New Media in Everyday Life and Technology.* (eds.) van den Boomen, M. et al. Amsterdam University Press pp. 81-94

D'Ignazio, C. (2015) *What would Feminist Data Visualisation look like?* [online] MIT Centre for Civic Media. Boston, MA. Available at https://civic.mit.edu/feminist-data-visualization [Accessed 21 December 2015]

Digits2Widgets. (2012) *3D Nylon Selective Laser Sintering and material data sheet.* [online] London. Available from http://www.digits2widgets.com/3DNylon.html [Accessed 10 December 2012]

Dutton, S. (2012) *Artists don't need PhD's but PhD's need artists. Perhaps.* [online] Available from http://duttsville.blogspot.co.uk/2012/05/artists-dont-need-phds-but-phds-need.html [Accessed 2 February 2015]

de Zegher, M. C. (1996) *Inside the Visible: an elliptical traverse of 20th century art in, of, and from the feminine.* Boston, MA: Institute of Contemporary Art. Kanaal Art Foundation.

Ehrenstein W. H. and Ehrenstein, A. *Pyschophysical Methods* p. 1213. Available from http://www.uni-leipzig.de/~isp/isp/history/explanation.htm [Accessed 26 April 2013]

Electro Optical Systems EOS GmbH (2006) *EOS launches FORMIGA P100 for plastic laser sintering* [online] Cambridge: Damte. Available from http://www.machinebuilding.net/p/p0261.htm [Accessed 3 February 2015]

Electro Optical Systems EOS GmbH (2015a) *Complex Geometries* [online] Krailing, Germany. Available from http://www.eos.info/additive_manufacturing/for_your_technical_innovation/challenge_complex_geometries [Accessed 2 February 2015]

Electro Optical Systems EOS GmbH (2015b) *FORMIGA P 110* [online] Krailing, Germany. Available from http://www.eos.info/systems_solutions/plastic/systems_equipment/formiga_p_110 [Accessed 2 February 2015]

Ervinck, N. (2016) *AGRIEBORZ (2009-2010)*. [3D Print] 53 x 34 x 33 cm. Available from _Studio_Nick_Ervinck [online] Lichtervelde Belgium. http://www.nickervinck.com/en/works/detail-2/agrieborz-3 [Accessed 19 February 2016]

Fujimura, J. (2003) "Future Imaginaries: Genome Scientists as Socio-Cultural Entrepreneurs," in A. Goodman, D. Heath, & S. Lindee (eds), *Genetic Nature/Culture: Anthropology and Science Beyond the Two-Culture Divide*. Berkeley: University of California Press. pp. 176–99.

Friedrich, C. D. (1824) *The Sea of Ice* [Painting] Oil on Canvas 96.7 x 126.9cm. Kunsthalle Hamburg. [online] Available from http://www.wga.hu/index1.html [Accessed 27 January 2015]

Gabrys, J. (2013) *Digital Rubbish: A Natural History of Electronics.* University of Michigan Press

Gallop, J. (1988) *Thinking Through the Body.* New York: Columbia University Press

Gane, N. and Haraway, D. (2006) "When We Have Never Been Human, What Is to Be Done?: Interview with Donna Haraway". *Theory, Culture & Society.* Sage. Vol. 23 no. 7-8 pp. 135-158.

Gilchrist, B. & Joelson, J. (eds.) (2002) *Syzygy/Polaria.* London: Black Dog Publishing

Gilchrist, B. & Joelson, J. (2005) *Little Earth.* London: London Fieldworks

Gilchrist, B. & Joelson, J. (eds.) (2012) *NULL OBJECT: Gustav Metzger thinks about Nothing.* London: Black Dog Publishing

Ginsberg, A. D. (ed.) (2011) *SYNTHESIS: Synthetic Biology Workshop Handbook.* London: The Arts Catalyst / UCL / Synthetic Aesthetics / SymbioticA / Synbion. Unpublished.

Google (2011) *Google Maps* [mobile application] San Francisco, CA. Apple Integrated Operating System (iOS) version 5. Platform iPhone 4S. [Accessed 2011-12]

Google (2011-15) *Google Maps* [online] San Francisco, CA. Available from http://www.google.com/maps [Accessed 2011-2015]

Greenfort, T. and Haraway, D. (2012) *The Worldly House.* Available from http://tuegreenfort.net/post/34698314235/the-worldly-house-2012-walking-through-the [Accessed 16 March 2016]

Hacking, I. (1985) "Do we see through a microscope?" from *Images of Science*: Essays on Realism and Empiricism. Van Fraassen, B. C., Churchland P.M., and Hooker, C. A. (eds.) pp. 132-52

Haptic - Dictionary definition. (2005-2011) from Dictionary software, Apple Inc. Version 2.2.1 (143.1) [Accessed 29 February 2016]

Haraway, D. (1991) "A Cyborg Manifesto: Science, Technology, and Socialist-Feminism in the Late Twentieth Century" from *Simians, Cyborgs and Women: The Reinvention of Nature.* London: Free Association Books. pp. 149-182

Harman, G. (2009) *Technology, objects and things in Heidegger.* Cambridge Journal of Economics Volume 34: Issue 1(pp. 1-9) [Accessed 21 November 2012] from http://cje.oxfordjournals.org/

Hayles, N. K. (1999) *How We Became Posthuman: Virtual Bodies in Cybernetics, Literature and Informatics.* University of Chicago Press

Hayles, N. K. (2002) *Writing Machines.* Cambridge MA: MIT.

Hayles, N. K. (ed.) (2004) *Nanoculture: Implications of the New Technoscience*. Bristol: Intellect.

Hayles, N. K. (2005) *My Mother Was a Computer: Digital Subjects and Literary Texts.* University of Chicago Press

Hayles, N. K. (2006) "The Time of Digital Poetry: From Object to Event" from *New Media Poetics: Contexts, Technotexts, and Theories.* Morris, A. and Swiss, T. (eds.) Cambridge: MIT. pp. 181-210

Hayles, N. K. (2009) Interview with Stacey Cochran [online] *The Artist's Craft,* Raleigh Television Network. Available at https://www.youtube.com/watch?v=tBhFYkaift4 [Accessed 2 February 2015]

Heidegger, M. (1977) *The Question Concerning Technology and Other Essays.* Translated by Lovitt, W. New York: Harper & Row. pp. 1-35 (1954)

Hesse, E. (1967) *Untitled.* [postcard] Pen and Ink. London: Tate

Hiller, S. and Kokoli, A.M. (ed.)(2008) *The Provisional Texture of Reality: Selected Texts and Talks 1977-2007.* Zurich: JRP Ringier.

Hopkinson, N., Hague, R. J. M., and Dickens, P. (2006) *Rapid Manufacturing: The Industrial Revolution for the Digital Age.* Chichester: John Wiley & Sons

iDAT (2011) *BIO-OS: DIY Human Geography v.1.0* Plymouth University and Liquid Press

iDAT (2013) *BIO-OS: DIY Human Geography v.1.0* [online] Plymouth University. Available at http://bio-os.org/projects/human-geography/ [Accessed 21 December 2015]

Ihde, D. (1979) *Technics and Praxis.* Dordrecht: D. Reidel

Ihde, D. (2010) *Heidegger's Technologies : Postphenomenological Perspectives.* New York: Fordham University Press

Irigaray, L. (1985) *This Sex Which is Not One*. New York: Cornell University Press.

Jones, A. (1998) *Body Art/ Performing the Subject*. Minneapolis: University of Minnesota Press.

Jones, B. W. (2015) *Apple Retina Display* [online] University of Utah: JonesBlog. Available from *http://prometheus.med.utah.edu/~bwjones/2010/06/apple-retina-display/* [Accessed 29 May 2015]

Jones, C.A. (ed.) (2006) *Sensorium: Embodied Experience, Technology and Contemporary Art.* Cambridge: MIT

S. Kasas, N. H. Thomson, B. L. Smith, P. K. Hansma, J. Miklossy, H. G. Hansma (1997) "Biological Applications of the AFM: From Single Molecules to Organs." *International Journal of Imaging Systems and Technology* [online] Volume 8 (pp. 151–161) Available from http://www.physics.uoguelph.ca/psi/papers/AFM/Hansma_IntJImagingSysTech97.pdf [Accessed 17 December 2012]

Kent, J. (2012) *Regenerating Bodies: Tissue and cell therapies in the twenty-first century.* London: Routledge.

Krauss, R. (1977) "Notes on the Index part 1. Seventies Art in America" *October.* Vol. 3 pp. 68-81 Boston: MIT

Kunit fra Umivik (1884) Wooden maps, detailing part of Greenland Coast (and Islands). Greenland National Museum and Archives, Nuuk. Available from http://www.thewalters.org/exhibitions/maps/image_pages/inuit.html [Accessed 24 November 2014]

Labaco, R. T. (ed.) (2013) *Out of Hand: Materialising the Post Digital.* London: Black Dog Publishing

Lancaster, J. (1973) *Introducing Op Art.* London: B. T Batsford.

La Frenais, R. (1994), "Taking the Alien Exam", MUTE Magazine, Pilot Issue. pp. 1-2, from La Frenais, R. (2005) *Ubiquity and Fluidity of Art, Science, Performance and Technology: 25 years of critical and creative curatorial practice 1979-2004.* London: Brunel University

La Roche, Frank. (date unknown) *Pioneer 19th Alaskan explorers T. J. Richardson and Frank La Roche (standing) look down, from 1,800ft, on Muir Glacier.* [photograph] Seattle: American Geographical Society. In Brown, D. (1972) *Alaska: The World's Wild Places.* London: Time Life pp. 30-31

Latour, B., November, V. and Camacho-Hübner, E. (2010) "Entering a risky territory: space in the age of digital navigation". *Environment and Planning D: Society and Space 2010,* volume 28. pp. 581- 599

Law, J. (2004) *After Method: Mess in Social Science Research.* London: Routledge

Lem, S. (1970) *Solaris.* Translated by Kilmartin, J. and Cox, S. London: Faber and Faber. (1961)

Lem, S. (1987) '*Solaris*' *by Tarkovsky: Lem about the Tarkovsky*'s *adaptation.* [online] Krakow. Available from http://english.lem.pl/arround-lem/adaptations/qsolarisq-by-tarkovsky/176-lem-about-the-tarkovskys-adaptation. [Accessed 5 December 2015]

Lem, S. (2002) '*Solaris*' *by Soderbergh: The Solaris Station.* [online] Krakow. Available from http://english.lem.pl/arround-lem/adaptations/soderbergh/147-the-solaris-station. [Accessed 22 May 2015]

Live Science (2015) "*3D-Printed Human Embryonic Stem Cells Created for First Time*" [online] TechMedia Network. Available from http://www.livescience.com/26865-3d-printed-embryonic-stem-cells.html [Accessed 22 September 2015]

London Fieldworks (2013a) *NULL OBJECT: Panel Discussion.* Joelson, J. and Gilchrist, B. with Metzger, G. Chair, Lambert, N. London: Central Saint Martins. 5 February 2013

London Fieldworks (2013b) *Null Object: Interview with Joseph Grima.* Domus. Issue 965 [online] Available from http://www.domusweb.it/en/interviews/2013/02/20/null-object.html [Accessed 13 April 2013]

Lyotard, J. F. (1982) "Presenting the Unpresentable: The Sublime", from Morley, S. (2010) (ed.) *The Sublime. Documents of Contemporary Art.* London: Whitechapel Gallery and MIT Press. pp. 130-136

MacFarlane, R. (2007) *The Wild Places.* London: Granta.

MacFarlane, R. (2016) *Generation Anthropocene: How humans have altered the planet forever.* London: The Guardian [online] 1 April 2016. Available from http://www.theguardian.com/books/2016/apr/01/generation-anthropocene-altered-planet-for-ever [Accessed 3 April 2016]

Manovich, L. (2001) *The Language of New Media*. Cambridge: MIT

Marks, L. U. (2002) *Touch: Sensuous Theory & Multi Sensory Media.* Minneapolis: University of Minnesota Press.

Materials Evaluation and Engineering, Inc. (2010) *The Handbook of Analytical Methods for Materials.* [online] Plymouth, MN. Available from http://www.mee-inc.com/hamm/atomic-force-microscopy-afm/ [Accessed 27 November 2012]

McKie, R. (2016) *Plastic now pollutes every corner of Earth: From supermarket bags to CDs, man-made waste has contaminated the entire globe, and become a marker of a new geological epoch.* 24 January 2016 London: The Observer [online] Available from http://www.theguardian.com/environment/2016/jan/24/plastic-new-epoch-human-damage [Accessed 24 January 2016]

Medina, C. and Fraga, C. M. (eds) (2012) *Manifesta 9: The Deep of the Modern: A Subcyclopaedia*. Milan: Silvana Editoriale Spa.

Mehaffy, M. M. (2000) "Fetal attractions: the limit of cyborg theory" in *Women's Studies: An Interdisciplinary Journal* 29.2 (2000) pp. 177-194. [online] Available from http://www.tandfonline.com/doi/abs/10.1080/00497878.2000.9979307 [Accessed 14 November 2015]

MeshLab (2012) Visual Computing Lab - ISTI - CNR [Software] v1.3.2_64bit (2 August 2012) Available from http://meshlab.sourceforge.net/ [Accessed 3 August 2012]

Metahaven (2012) Artist Talk at Spike Island, Bristol. 23 February 2012 [http://www.spikeisland.org.uk/events/talks/designers-talk-metahaven/]

Metzger, G. (1959) *Auto-Destructive Art* [online] Available from http://radicalart.info/destruction/metzger.html [Accessed 13 April 2013]

Metzger, G. (1960) *Manifesto Auto-Destructive Art* [online] Available from http://radicalart.info/destruction/metzger.html [Accessed 13 April 2013]

Metzger, G. (1961) *Auto-Destructive Art Machine Art Auto-Creative Art* Available from http://radicalart.info/destruction/metzger.html [Accessed 13 April 2013]

Molesworth, H. (1993) "Before Bed". [online] October, Vol. 63 (1993) pp. 68-82 Cambridge MA: MIT. Available from http://www.jstor.org/stable/778865 [Accessed: 22 December 2015]

Morton, T. (2011) *Zero Landscapes in the Time of Hyperobjects* [online] Graz Architectural Magazine, Issue 7: pp. 78-87 Available from http://www.academia.edu/1050861/Zero_Landscapes_in_the_Time_of_Hyperobjects [Accessed 4 August 2015]

Munster, A. (2006) *Materialising New Media: Embodiment in Information Aesthetics.* Hanover: University Press of New England.

Nano Science Instruments. (2012) *Atomic Force Microscopy Technology Overview* [online] Phoenix, AZ, USA. Available from http://www.nanoscience.com/education/afm.html [Accessed 16 December 2012]

Nead, L. (1992) *The Female Nude* London: Routledge

Nelson, M. (2011) *The Art of Cruelty: A Reckoning.* New York: Norton.

Nelson, R. (2006) "Chapter 7: Modes of PaR knowledge and their place in the Academy". pp. 1-24. [online] Available from https://www.westminster.ac.uk/__data/assets/pdf_file/0011/74594/Robin Nelson.pdf [Accessed 2 December 2015]

New Scientist (2000) "*Imagine an Object and It Will Appear*" *Front Cover.* (September 2000) Referenced by London Fieldworks (2013) Available from http://www.domusweb.it/en/interviews/2013/02/20/null-object.html [Accessed 13 April 2013]

Nintendo (1992) "Ghost Valley" from *Super Mario Kart.* Super Nintendo. [Video game] Tokyo. [online] Available from http://www.youtube.com/watch?v=Ux6g2CBJfh0 [Accessed 4 March 2016]

Nusca, A. (2012) *3D Printing: The Hype the Hopes the Hurdles*. [online] San Francisco: CNet. Available from http://news.cnet.com/8301-11386_3-57549959-76/3d-printing-the-hype-the-hopes-the-hurdles/ [Accessed 18 December 2012]

Olay (2016) *Olay Regenerist Micro-Sculpting Cream Moisturiser.* [online] Available at http://www.olay.com/en-us/skin-care-products/regenerist-micro-sculpting-cream-moisturizer [Accessed 14 February 2016]

Olson, C. (1965) *Proprioception.* San Francisco CA: City Lights.

Opacifying agent definition (2013) From *Cosmetics Info: The Science & Safety Behind Your Favorite Products* [online] http://www.cosmeticsinfo.org/glossary/letter_o#Opacifying_Agent [Accessed 14 February 2016]

Organogenesis (2016) [online] Canton MA. Available from http://www.organogenesis.com/ [Accessed 4 March 2016]

O'Reilly, S. (2009) *The Body in Contemporary Art*. London: Thames & Hudson

Papanek, V. (1995) *The Green Imperative: Natural Design for the Real World.* London: Thames and Hudson. Chapter 11. pp. 223-23.

Parks, L. (2005) *Cultures in Orbit: Satellites and the Televisual.* Durham, NC: Duke University Press.

Parks, L. (2012) "Zeroing In: Overhead Imagery, Infrastructure Ruins and Datalands in Afghanistan and Iraq," in *The Visual Culture Reader.* Mirzoeff, N. (ed.) London: Routledge.

Paul, C. (2013) "Objecthoods From the Desktop" from *Out of Hand: Materialising the Post Digital.* Labaco, R. T. (ed.) London: Black Dog

Personal Care Products Council (2013) *Cosmetic Ingredients Review.* [online] Washington DC. "Nylon Ingredients: Safety" Available at http://www.cosmeticsinfo.org/ingredient/nylon-ingredients [Accessed 6 December 2015]

Petchesky, R. P. (1987) "Fetal Images: The Power of Visual Culture in the Politics of Reproduction" from, *Feminist Studies,* Vol. 13, No. 2: pp. 263-292 [online] Available from http://www.jstor.org/stable/3177802 [Accessed 10 December 2015]

Pickering, A. (1994) "After Representation: Science Studies in the Performative Idiom" from *PSA: Proceedings of the Biennial Meeting of the Philosophy of Science Association.* Volume Two: Symposia and Invited Papers (1994) University of Chicago. pp. 413-419.

Pioneers in Art and Science: Gustav Metzger (2004) [Documentary, DVD] Directed by Ken McMullen. London: Arts Council England.

Quasha, G. and Stein, C. (2000) "HanDHearD / Liminal Objects" from Morley, S. (2010) (ed.) *The Sublime. Documents of Contemporary Art.* London: Whitechapel Gallery and MIT Press. pp. 214-216

Reilly, L. (2002) "An alternative model of "knowledge" for the arts." [online]. *Working Papers in Art and Design 2*. Available from http://sitem.herts.ac.uk/artdes_research/ papers/wpades/vol2/reillyfull.html [Accessed 20 April 2012]

Richardson, L. and St. Pierre, E. A. (2005) "Writing: A Method of Enquiry" from Denzin, N. K. and Lincoln, Y. S. (eds.) *The Sage Handbook of Qualitative Research: Third Edition.* London: Sage. pp. 959-978

Sample (2015) "*UK scientists seek permission to genetically modify human embryos: Researchers apply for licence months after Chinese team become first to announce they have altered DNA*". 18 September 2015 London: The Guardian [online] Available from http://www.theguardian.com/science/2015/sep/18/uk-scientists-seek-permission-to-genetically-modify-human-embryos [Accessed 18 September 2015]

Sayre, H. M. (1989) *The Object of Performance: The American Avant-Garde Since 1970.* "OPEN SPACE: Landscape and the Postmodern Sublime." University of Chicago Press. pp. 211-245

Scarry, E. (1985) *The Body In Pain: The Making and Unmaking of the World.* Oxford University Press

Schmidt, M. (2013) *The First Fully-Articulated 3D Printed Gown, Featuring Dita Von Teese* [online] 7 June 2013 Available from http://www.youtube.com/watch?v=3cFdbxMhtoA [Accessed 15 April 2016]

Seeker Network: Discovery Communications, LLC. (2013) *Fighting Rhino Poaching With a 3D Printer* [online] Silver Springs MD. Available from http://www.seekernetwork.com/fighting-rhino-poaching-with-a-3d-printer-1501525615.html [Accessed 11 January 2016]

Seeker Network Discovery Communications, LLC. (2015) *3D Printing Could Save Your Child's Life.* Facebook [online] 29 December 2015. Available from https://www.facebook.com/SeekerNetwork/videos/1087439031280251/?fref=nf [Accessed 11 January 2016]

Sickels, R. C. (2004) *The 1940s: American Popular Culture Through History.* Santa Barbara CA: Greenwood

Siddique (2016) "*British researchers get green light to genetically modify human embryos: Scientists investigating miscarriage will not be able to implant embryos or study them for more than two weeks, says HFEA*" 1 February 2016 London: The Guardian [online] Available from http://www.theguardian.com/science/2016/feb/01/human-embryo-genetic-modify-regulator-green-light-research [Accessed 1 February 2016]

Sladen, M. (ed) (2004) *Helen* Chadwick: A Retrospective. London: Barbican / Hatje Cantz

Solaris (1972) [film, DVD] 169 mins. Directed by Andrei Tarkovsky. Moscow: Mosfilm Studio/World Cinema Ltd.

Steyerl, H. (2011) *In Free Fall: A Thought Experiment on Vertical Perspective.* e-flux journal #24 April 2011 [online] Available from http://www.e-flux.com/journal/in-free-fall-a-thought-experiment-on-vertical-perspective/ [Accessed 30 November 2011]

Steyerl, H. (2012) "*Aesthetic of Resistance*" from *Intellectual Birdhouse: Artistic Practice as Research.* Bauer, U. M. (ed.) London: Koenig pp. 55-64

Thacker, E. (2003) "DATA MADE FLESH: Biotechnology and the Discourse of the Posthuman." From *Cultural Critique No. 53 Posthumanism* (Winter, 2003) Minneapolis: University of Minnesota Press. pp. 72-97

Tissandier, Z. (2013) *In Praise of Scribes.* HD Video, 26 mins. [online] Available from http://zoetissandier.co.uk/artwork/in-praise-of-scribes/?1 [Accessed 6 February 2016]

Transmediale (2013) *Back When Pluto Was A Planet* [Catalogue] Gansing, K. et al. (eds.) Berlin.

Trocola, A. (2012) *Global PA2200 Supply Disruption* [online] Norwalk CT. Available from http://40westdesigns.com/blog/?p=340 [Accessed 18 December 2012]

Verhoeff, N. (2012) *Mobile Screens: The Visual Regime of Navigation.* Amsterdam: Amsterdam University Press

Visual News (2015) *Blind Mother Can "See" Her Baby's Ultrasound Thanks to 3D Printing Technology.* [online] Irvine CA: Column Five Media. Available from http://www.visualnews.com/2015/05/10/blind-mother-can-see-her-babys-ultrasound-thanks-to-3d-printing-technology/) [Accessed 5 December 2015]

Walker, S. (2013) *Helen Chadwick: Constructing Identities Between Art and Architecture.* London: I.B.Tauris

Walters, P. and Davies, K. (2010) *3D printing for artists: research and creative practice.* [online]. Rapport: Journal of the Norwegian Print Association*, 1*. pp. 12-15. Available from http://www.norske-grafikere.no/resources/docs/Rapport_nr_1-2010.pdf [Accessed 2 March 2014]

Wanderley, L. (1993) *Nostalgia du corpo.* Unpublished lecture. From de Zegher, M. C. (1996) *Inside the Visible: an elliptical traverse of 20th century art in, of, and from the feminine.* Boston, MA: Institute of Contemporary Art. Kanaal Art Foundation. p. 424

Warr, T. (1998) "The *Informe* Body" in *Performance Research 3 (2).* London: Routledge pp. 118-121

Warr, T. (2001) "Tuning In" in Gilchrist, B. and Joelson, J. (eds.) London Fieldworks *Syzygy\Polaria.* London: Black Dog Publishing. pp. 6-11

Warr, T. (2010) "Texts from the Body: Bruce Gilchrist" in Broadhurst, S. and Machon, J. (eds.), *Sensualities/Textualities and Technologies: Writings of the Body in 21st Century Performance*, New York: Pallgrave Macmillan. pp. 23-27

Warr, T. (2000/2012) *The Artist's Body.* London: Phaidon.

Warr, T. (2012) "The Body in Your Lap", in M. Chatzichristodoulou and R. Zerihan (eds.) *Intimacy: Across Visceral and Digital Performance.* Basingstoke: Palgrave Macmillan

Westerman, J. and Lee, J. (2006) *Drafts/Draughts. Transmission: The Rules of Engagement 9.* London: ArtWords Press

Wikipedia (2012) 10 micrometres, in *Wikipedia* [online] Available from http://en.wikipedia.org/wiki/10_micrometres [Accessed 27 November 2012]

Wikipedia (2013) Google Maps, in *Wikipedia* [online] Available from http://en.wikipedia.org/wiki/Google_Maps [Accessed 16 December 2013]

Wikipedia (2013) Null Object pattern, in *Wikipedia* [online] Available from http://en.wikipedia.org/wiki/Null_Object_pattern [Accessed 20 April 2013]

Willet, J. (2013). "Performing Biotechnology: Reimagining inter-artist/interspecies interrelations in the laboratory with Kira O'Reilly" from *BIO/ZOO* Volume 10, Issue 1 (Winter 2013) [online] New York Available from http://hemisphericinstitute.org/hemi/en/e-misferica-101/willet [Accessed 23 September 2015]

Wilson, S. (2002*) Information Arts: Intersections of Art, Science and Technology.* Cambridge: MIT.

Worlding.org (2016) [online] Author: David Trend. Professor and Chair, Department of Art, University of California, Irvine. Available from http://worlding.org/what-in-the-world-2/ [Accessed 7 March 2016]

Ziarek, K. (2001) *The Historicity of Experience: Modernity, the Avant-Garde, and the Event.* Illinois: Northwestern University Press.

Ziarek, K. (2005) "The Work of Art in the Age of its Electronic Mutability". In: Benjamin, A., (ed.) *Walter Benjamin & Art.* London: Continuum, pp. 209-225.

Zielinski, S. (2006) *Deep Time of the Media: Toward an Archaeology of Hearing and Seeing by Technical Means.* Cambridge: MIT

—

Art Monthly (2011-12) Letters between Price, E., Charlesworth, J.J., and Suchin, P. in response to Suchin, P. *Rebel Without a Course.* London: *Art Monthly* (April 2011, No. 345) pp. 11-14.

Art Monthly Feb 2012 No. 353 Charlesworth p. 15
Art Monthly Dec 2011- Jan 2012 No. 352 Anonymous, Suchin pp. 16-17
Art Monthly Nov 2011 No. 351 Price, Suchin pp. 13-14
Art Monthly Oct 2011 No. 350 Price, Suchin pp. 17-18
Art Monthly May 2011 No. 346 Kholeif p. 12

Exhibitions

Out Of This World: Science Fiction but not as you know it (2011)
London: British Library. 20 May - 25 September 2011

Barry Flanagan: *A Hole in the Sea,* (1969), *3' 45"* from
LAND ART by Gerry Schum (*1969) Fernsehausstellung I / TV exhibition*
Installed as part of *Remote Control* (2012)
London: ICA. 3 April - 10 June 2012

dOCUMENTA (13) Kassel, Germany 2012
Greenfort, T. and Haraway, D. (2012) *The Worldly House*

Neoreplicants (2012) Group Show. Curator: Matt Burrows
Exeter: Phoenix Gallery. 16 November 2012 - 19 January 2013

London Fieldworks. *NULL OBJECT: Gustav Metzger thinks about nothing.*
(2012) London: WORK Gallery. 30 November 2012 – 9 February 2013

Nancy Holt & Robert Smithson: England and Wales 1969 (2013)
Southampton: John Hansard Gallery 10 May - 17 August 2013

Ana Mendieta: *Traces* (2013)
London: Hayward Gallery. 24 September – 15 December 2013

The Negligent Eye (2014) Group Show. Curator: Jo Stockham.
Liverpool: The Bluecoat. 8 Mar - 15 Jun 2014.
Available from http://www.thebluecoat.org.uk/blog/view/who-is-blogging/139 [Accessed on 24 February 2014]

Lines in the Ice: Seeking the Northwest Passage (2014-15)
London: British Library. 14 November - 29 March 2015

Appendices

1. PURE FLOW 2.0

2. Digital Materiality: email from Ashley Scarlett, PhD Candidate
   University of Toronto, January 2014

3. Atomic Force Microscopy: Description Of Technique

4. Photographs of AFM Scan
   Wolfson Nanotechnology Laboratory, Plymouth University

5. James Bridle, Talk at EMERGE, Bournemouth University
   [Selected Transcript:: Q & A] 15 May 2013

6. Interview with Mr. James Bradbury [Redacted Transcript]
   Centre for Additive Layer Manufacturing (CALM)
   Exeter University, 5 February 2014 (pp. i - xiv)

7. Katy Connor CV

8. BU Graduate School Santander Grant Applications (2012 - 13)

9. Full email correspondence between Katy Connor and CALM
   Exeter University, July 2012 - October 2014 (46 pages)

10. *neoreplicants,* Exeter Phoenix Gallery Text
    16 November 2012 - 19 January 2013

11. *3DPRINTSHOW* London: Industry & Design Conference
    Brochure (selected pages) 7 - 9 November 2013

12. Promotional video 3D Systems' *Sinterstation*

13. Email correspondence with Professor Genhua Pan, Professor of
    Spintronics and Nanomagnetism, Plymouth University
    November 2012

14. Correspondence with David Roden, January 2016

15. Peer Critique [Full Transcript] *Zero Landscape* exhibition
    Test Space Spike Island, Bristol, 5 February 2016 (pp. i - xv)

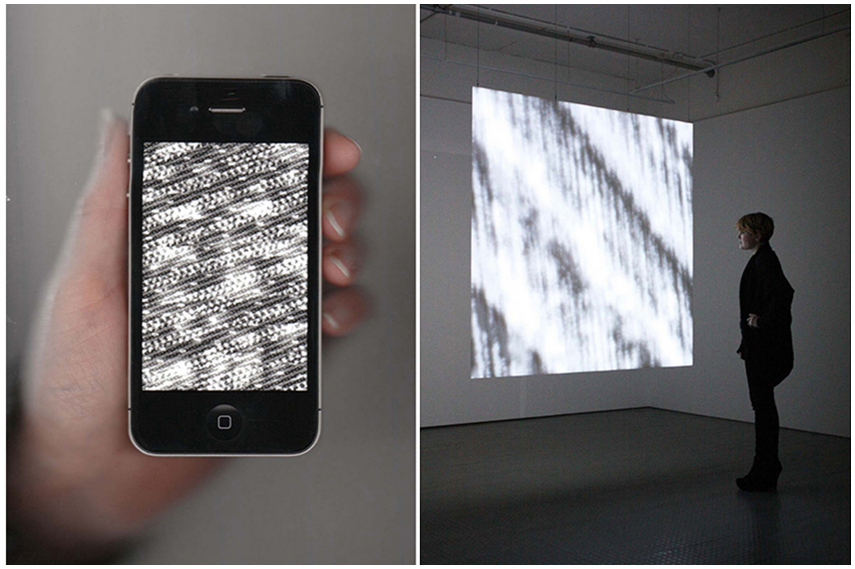
16. *Zero Landscape* Gallery Text, January 2016

17. Email from artist Sophie Warren, January 2016

18. Publications

19. Ethics Release Forms from Contributors to the Research

Appendix 1: *PURE FLOW 2.0 [mobile edition]*[1]



Left: ***PUREFLOW 2.0*** [mobile edition] iPhone / iPad App (2011)
Right: ***PUREFLOW*** Installation, Exeter Phoenix (2009)

PURE FLOW is a recent digital work that has three different outputs:

- an audio visual installation
- an app for the smartphone and iPad
- a Lithographic print outlining the concept of the work

PURE FLOW reveals the ordinarily invisible streams of data running between a Global Positioning System [GPS] and the multiple satellites that triangulate its position. This data generates live, moving imagery and sound from the noise in the signal: the fluctuations, received by a static device revealing its instability.

Conceptually, the piece subverts the use-value of the GPS navigational device as a surveying and navigational tool, whilst simultaneously providing a new way of seeing the streams of invisible data; hi-lighting their increasing ubiquity as sophisticated military technologies become key components in daily life through their use in Sat-Nav devices and mobile phones.

Treating the GPS NMEA data as source material or 'found footage', I collaborated with a programmer to create audiovisual material out of the streaming data - that would display no reference to maps or a utilitarian usage.

[1] This text was written as part of my Initial Review document for the PhD. (March 2012)

PUREFLOW 2.0 [mobile edition] A2 Lithographic Print (2011)

Visually the work references dense, grainy static - or white noise - a very simple aesthetic coming from the concept: the work flows over the audience experientially, rather than visually. Audio references are glitch artists Pan Sonic and sound artist Christina Kubisch: what we see and hear is the underlying Noise derived from the machine - or another way of tuning into the signal. The final work reveals invisible data streams present in the environment, those between a static GPS device and its multiple satellites, in the form of an audio/visual installation.

PURE FLOW 2.0 transforms the experience of the work into a miniature, hand held app for a mobile and global audience. This miniaturisation expands the potential for audience accessibility and interactivity with the work making the GPS data system into a tangible presence in the environment.

PURE FLOW 2.0 articulates a critical space to consider the internal workings of mobile technology and the ubiquitous invisible webs that structure contemporary network culture. It subverts the use-value of the GPS by exposing its fragility and instability. It prompts an awareness of space; how technologies contribute to and structure our lives; rather than their implicit use in the cultural pursuit of total predictability and control. It creates a cultural space for uncertainty in the digital age.

The A3 print provides a haptic, tactile way of engaging with the work - and presents the core concepts of the piece in a material, printed form. This complex relationship between the tangible object and its audio-visual, networked other is a space I'm currently investigating through my artistic research.

Presentations of the work

2009 Exhibition: installation at Exeter Phoenix Gallery

2011 Launch of mobile app, Brighton Digital Festival

2011 Interview broadcast on BBC *Click*, World Service / online

2011 Exhibition: Solo show at Plymouth Arts Centre

2011-12 Online Exhibition: *The Right to know and Copy*, Impakt NL

2012 Presentation at the LUX Biennial of Moving Image, ICA London

2012 Online publication: ePermanent

2013 New iteration of app developed for the Android Platform

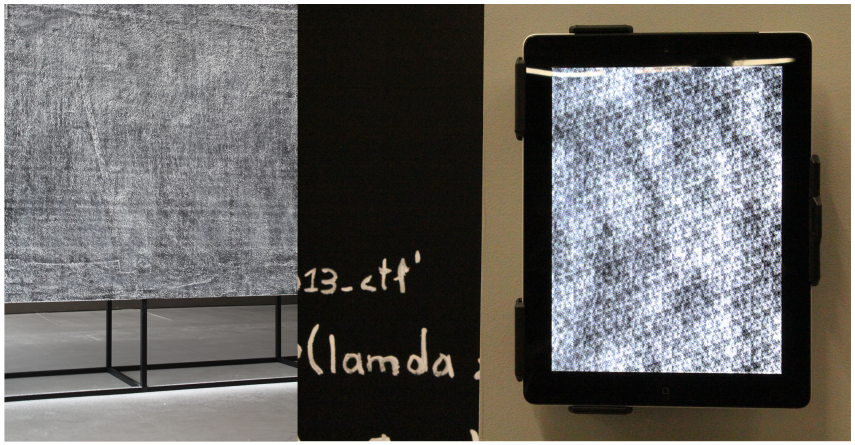
2013 Exhibited at Transmediale Berlin BWPWAP

2013 Selected for the Lumen Prize Exhibition

2014 Lumen Prize Tour: London, Hong Kong, Athens, New York

2017 (Proposed) Exhibition: Kunsthalle Exnergasse, Vienna
Curator Giulia Pistone

Transmediale 2013



Above left: *Blackboard Intervention*, post-performance
Above right: Pure Flow 2.0 exhibited on interactive iPad, with sound

Tools of Distorted Creativity

Curator Jacob Lillemose

Transmediale 2013: Back When Pluto Was a Planet

Haus der Kulturen der Welt, Berlin

29 January - 3 February 2013

http://transmediale.de/content/pure-flow-mobile-edition-0

Exhibition: *Tools of Distorted Creativity* and *Library of Extra Curricular Material, Transmediale 2013: BWPWAP,* HKW Berlin

Katy Connor, *Blackboard Intervention* (Performance - 31 January 2013 12 pm)

Tools of Distorted Creativity

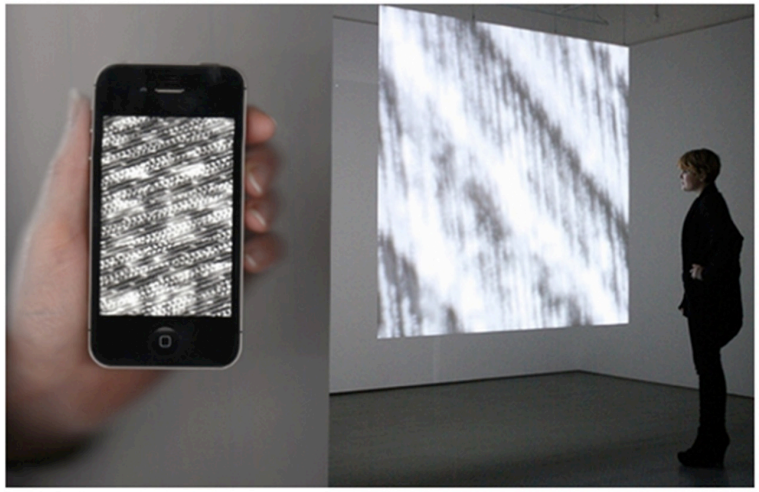
"Software is mind control—get some" i/o/d

"Through a selection of 12 artists, Tools of Distorted Creativity questions the notion of creativity that has been instrumental to the development of the personal computer, from its first stationary instantiations in the 1980's to today's mobile devices. Since its introduction, the personal computer has embodied the dream of the creative machine that allows the user to expand and explore her creative potential, rather than making her a slave of the machine. The personal computer itself is, however, only half of this story about machine-aided creativity. The other and equally important half of the story are the software tools at the user's disposal within the machine environment. Each of these hundreds of thousands of tools presents certain forms of perception, ways of thinking and modes of acting, that in turn activate certain kinds of creativity. So rather than being a general notion, creativity needs to be recognized as a multiplicative and diverse form of practice. Creativity also needs recognition as the source of open potential for tools yet to be invented.

Tools of Distorted Creativity investigates how artists have challenged the paradigmatic notion of creativity introduced by the user-friendly personal computer revolution. The artists present their challenge by producing entirely new tools and modifying or "misusing" tools that are already around. Beyond the normative credo to be creative, the artists in the exhibition rediscover the original rebelliousness associated with the notion of creativity offered by the personal computer and its tools. They explore creativity as an unexpected and disruptive act opposing its assimilation into the creative industries' processes of cultural smoothening, conformism and standardization. Discarding the prescribed and conventional use (and understanding) of tools, the works engage in an investigative and speculative reflection on the tools and their implied cultural order. The works encourage users to engage in a more undisciplined kind of tool use, turning creativity into a critical techno-cultural language. It is a language that refuses the logic of office-speak and rather, like Jimi Hendrix and his handling of the electric guitar, takes its point of departure in experimental sensibilities and intelligences that reinvent the notion and use of the tool for other disobedient expressions and purposes."

Transmediale (2013) *Back When Pluto Was A Planet.* Catalogue, pp. 10-11.

Pure Flow [mobile edition]



© Katy Connor

Katy Connor

Year: 2013
***Format*:**software

Multiplatform GPS software application. Presentation format: Interactive iPad with sound.
> katyconnor.com

Using GPS (Global Positioning System) has become an integrated and ubiquitous part of everyday life in today's networked world. There are stories of people who trust the system too much and get lost or hurt and of its use for surveillance. But in general, it is perceived as an effective tool to help us navigate simple and complex terrain. Pure Flow inverts this use-value by revealing the noise generated between GPS data systems and multiple satellites, 3G networks and Wifi hotspots, as a tangible presence in the environment. It reflects the instability and fragility of Live signals, passing through cloud cover and urban architecture, absorbed by bodies, reflecting off concrete and refracting through glass. The outcome is a sliver of fluctuating white noise, responding directly to the device's movement and immediate environment (either mobile or fixed). The user can directly manipulate the visual and sonic patterns triggered by fluctuations in data by touching the screen. Hence, the work transforms the GPS system into an instrument of abstraction or into a tool to explore the materiality of noise that is normally reduced to enable user-friendly communication.

■ Related content:

Tools of Distorted Creativity

PURE FLOW

[mobile edition]

2.0

PURE FLOW reveals the noise within mobile location networks, enabling its user to perceive, touch and create their own live data compositions.

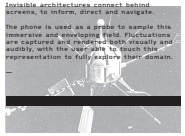
PURE FLOW is generative, open-ended and unpredictable: it exists within systems of flux that oscillate between the near and far, haptic and optic, visible and invisible, revealing new perceptions of the technological systems in which we are embedded.

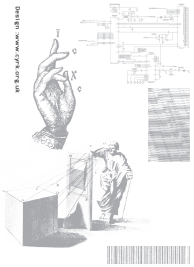
—

These networks lie at the threshold of everyday visibility ... satellites moving persistently through orbit ... phone mast transmission ... wifi connection ... invisible architectures context behind screens, to inform, direct and navigate.

The phone is used as a probe to sample this immersive and enveloping field. Fluctuations are captured and rendered both visually and audibly, with the user able to touch this representation to fully explore their domain.

—





“Our society is constructed around flows of capital, flows of technology, flows of organizational interaction, flows of images, sounds and symbols. Flows are not just one element of the social organization; they are the expression of processes dominating our economic, political and symbolic life.”

— Castells / The Rise of the Network Society

“Machines for seeing modify perception”

— Paul Virilio

“All images produced by electronic and digital technologies are transformations and combinations of intensities, forces, fields, taking place in the flow”

— Maurizio Lazzarato

“Life can never be too disorienting”

— Guy Debord

PURE FLOW
[mobile edition]

Accessible via iTunes, with versions for iPad and iPhone.

CREDITS

Concept / Artist:_____Katy Connor
Producer:_____Dr Duncan Rowland
Developer:_____Joshua O’Rourke

SUPPORTED BY

The University of Lincoln and The National Lottery through Arts Council England

LOTTERY FUNDED

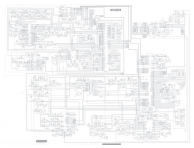
UNIVERSITY OF LINCOLN

Solo Show 1-28th September 2011 Permanent Gallery, Brighton UK.
– brightondigitalfestival.co.uk
Launched as part of Brighton Digital Festival
– www.permanentgallery.com

Group show – FVAC Associate Artists, 9th September – 1st October 2011
Plymouth Arts Centre, Devon
– www.plymouthartscentre.org

Solo Show 8th – 22nd October 2011
Plymouth Arts Centre, Devon
– www.plymouthartscentre.org

www.katyconnor.com



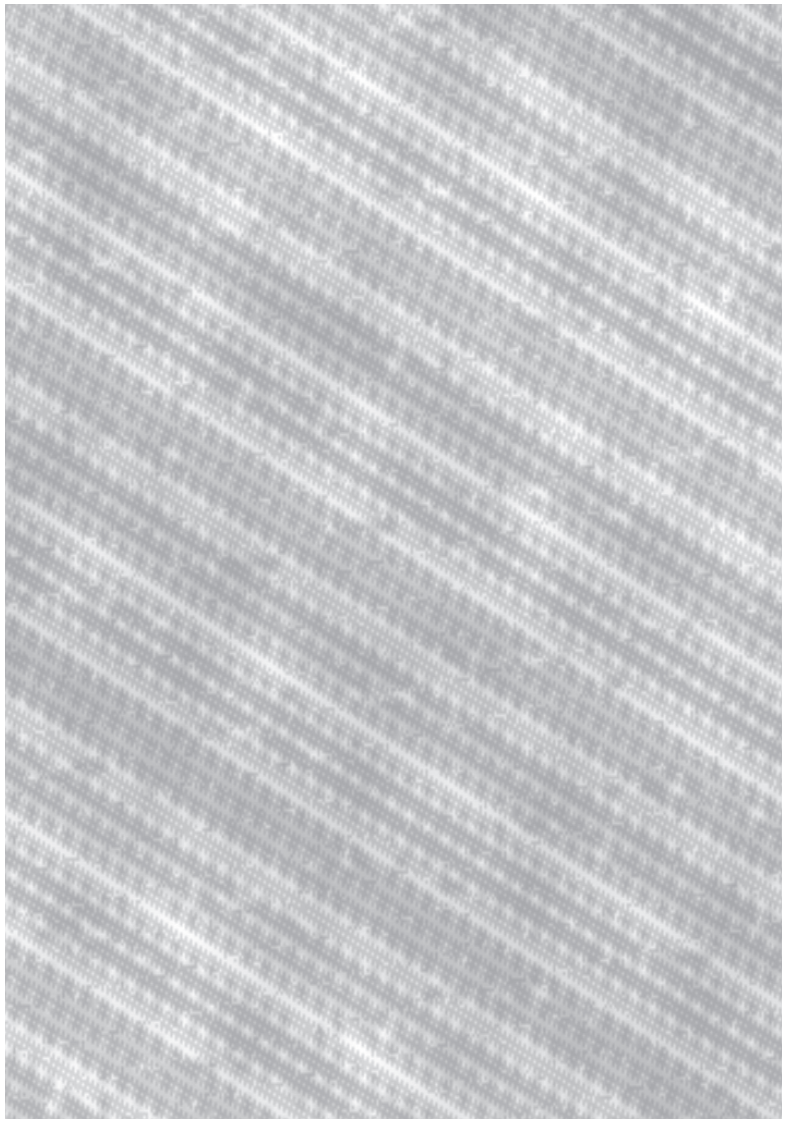
PURE FLOW [mobile edition] is a miniature, hand held application for a mobile and global audience, revealing the noise generated between GPS data systems and multiple satellites, 3G networks and Wifi hotspots as a tangible presence in the environment.

The APP visualises the instability and fragility of Live signals, passing through cloud cover and urban architecture; absorbed by bodies, reflecting off concrete and refracting through glass.

The user can directly manipulate the outcomes, by touching the visual and sonic patterns triggered by fluctuations in the data.

Once activated, PURE FLOW reveals these signals as a silver of fluctuating white noise, responding directly to the movement and immediate environment of the device.

PURE FLOW subverts the use-value of GPS as a surveying and navigational tool: revealing these invisible data streams and highlighting their increasing ubiquity, as sophisticated military technologies become key components in daily life.



Appendix 2: Digital Materiality

Email from Ashley Scarlett,
PhD Candidate, University of Toronto
January 2014

On Sat 25/01/14 15:55 Ashley Scarlett sent:

Dear Katy,

My name is Ashley Scarlett and I am a doctoral candidate at the University of Toronto, in the Faculty of Information. Working in close collaboration with Semaphore, a UofT based New Media maker and research cluster, my doctoral research explores contemporary new media artworks and making practices as a grounded means of engaging with the theoretical parameters of ' digital materiality,' an elusive phenomenon that is emerging as a critical area of inquiry for our time.

While researching this topic, your conceptual approach and several of your works have come to the fore as meaningfully related to several areas of my doctoral research - I am particularly interested in your works Pure Flow and Untitled Force, as they suggest that there is quite a bit of overlap between what I am thinking about and what you are working on/thinking about.

Anyway, all of this to say: I am writing to ask if you would be interested in participating in my doctoral project, currently titled: “Digital Matter: Investigating the Materiality of New Media Art Materials.” In an effort to augment my own historically grounded and philosophically motivated critiques of relevant contemporary artworks, I am approaching several key artists to discuss their work and affiliated making practices. These discussions will take place through semi-structured interviews, conducted in-person (when possible,) or via Skype. They are expected to take approximately 1 hour.

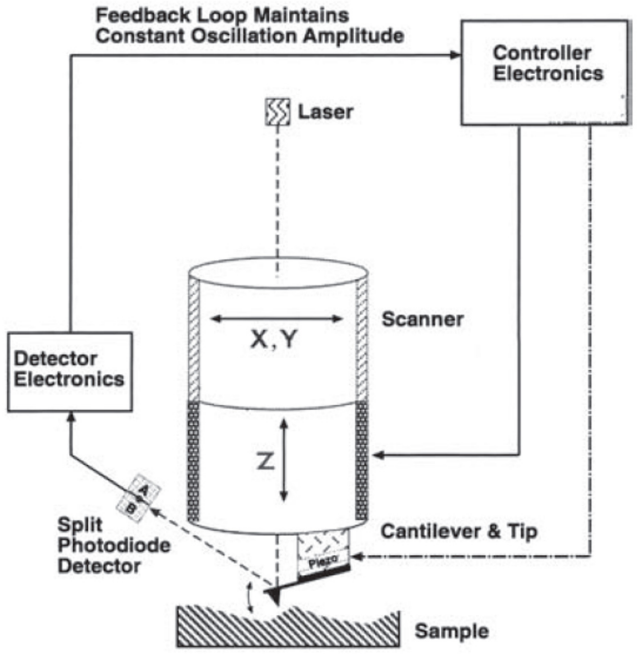
If this is something that you may be interested in participating in, please let me know via email - I would be thrilled to have an opportunity to discuss your work further with you, at your convenience. I'm currently trying to schedule these interviews for mid-late February. If that doesn't work for you, we can discuss a better time.

Sincerely,

A.

Appendix 3:

Atomic Force Microscopy: Description Of Technique



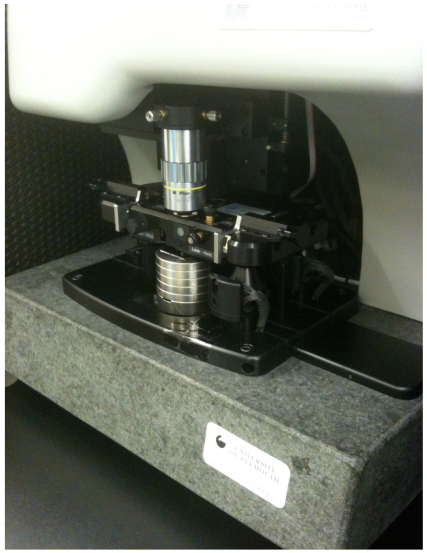
Sketch of AFM Instrument Configuration

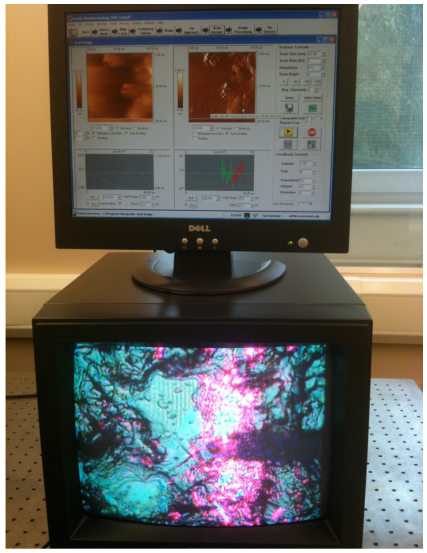
From *Handbook of Analytical Methods for Materials*
(Materials Evaluation and Engineering, Inc. 2010)

"Atomic Force Microscopy (AFM) is a form of scanning probe microscopy (SPM) where a small probe is scanned across the sample to obtain information about the sample's surface. The information gathered from the probe's interaction with the surface can be as simple as physical topography or as diverse as measurements of the material's physical, magnetic, or chemical properties. These data are collected as the probe is scanned in a raster pattern across the sample to form a map of the measured property relative to the X-Y position. Thus, the AFM microscopic image shows the variation in the measured property, e.g. height or magnetic domains, over the area imaged.

The AFM probe has a very sharp tip, often less than 100Å diameter, at the end of a small cantilever beam. The probe is attached to a piezoelectric scanner tube, which scans the probe across a selected area of the sample surface. Interatomic forces between the probe tip and the sample surface cause the cantilever to deflect as the sample's surface topography (or other properties) changes. A laser light reflected from the back of the cantilever measures the deflection of the cantilever. This information is fed back to a computer, which generates a map of topography and/or other properties of interest. Areas as large as about 100μm square to less than 100 nm square can be imaged." (Materials Evaluation and Engineering, Inc. 2010, p. 7)

Appendix 4: Photographs of AFM Scan, Wolfson Nanotechnology Laboratory, Plymouth University





Above: The performative scan of the blood sample

Below: Wolfson Nanotechnology Lab

Appendix 5:

James Bridle, Talk at EMERGE, Bournemouth University [Selected Transcript: Q & A] 15 May 2013

The talk was part of a series titled, 'Art in the Expanded Field; Digital Media, Networks and Technology' organised by the author, as an element of EMERGE (Experimental Media Research Group) Bournemouth University.

James Bridle: "If we talk about book and e-books, 5-10 years ago, to people who worked in publishing and the wider public, if you said e-books with them, they would just go 'No No No - I hate them, they're awful its a really terrible idea, I like Books' and you say, 'well why do you like books?' And they say, 'you know the feel of the paper and the smell of the book,' and I'm like, 'really? That's why you like books? That seems like the worst thing ever.' And of course it's proved they're wrong by the fact that most people who buy a Kindle don't go back.

There's vast amounts of electronic media going on now; it's growing all the time and we always knew that would happen. It's just like MP3s and vinyl - vinyl's lovely, people still collect it but let's be honest, most people just start gathering stuff in volume for all the reasons that its more convenient...

But trying to understand the reasons why people cling to things like that;
I started to understand it as - they'd use physical reasons because they didn't have the language to describe their other discomforts with it; and those discomforts for me are largely temporal rather than physical. People understood that books were like repositories for really important information that exists over time. Not just the time you spend with the book, the time people spend to write it, but the time you spend afterwards; the souvenir qualities, that it remains with you afterwards.

Because no one can see how that works digitally, our suspension of the ephemerality of the digital stuff meant they had no way of talking lucidly about how they actually felt about books, and that - I think that continues through all kinds of technologies.

It continues when people talk about the drones [see http://shorttermmemoryloss.com/portfolio/project/drone-shadows/] because they have no good metaphors or meta-models - debate is simply impossible. Printing it out and making endless models of it is designed to prod and poke."

Question: "In making it material again, people can reengage with it?"

JB: "I refuse to be convinced that that's the only way to talk about digital stuff. As a necessary, intermediate point - it does work, it's a cheap trick, but it works - but hopefully it will upgrade to better understandings."

Question (Katy Connor): "I think there's something really important about the tactile quality of something - that is an object that people can be in the same room with, rather than something floating in a conceptual void. It's an important part of peoples understanding."

JB: "Yes but my problem with that entirely, is that it privileges the physical over the virtual in really significant ways, and it leads to this weird situation we're in, where we all privilege physical interaction, yet we all have incredibly emotionally personal transformative experiences that are entirely digital.

"The idea - thankfully you hear it less and less these days - but that friends on Facebook aren't your real friends, it's like, Bollocks they are actually. I've made some of the deepest and most important connections of my life in virtual spaces and thru virtual communication.
I've had experiences entirely mediated by technology, by digital experiences, and if I'm capable of that intellectually and emotionally - to have these kind of experiences, then I refuse to privilege the physical tactility of 'things' over the digital stuff as well."

Question (Dr. Stephen Bell): "Can't it have an equal position? Or do you wish to privilege the digital? Physical engagement with the environment is something very ancient."

JB: "Yes. I am guilty of that oppositional thinking."

Appendix 6:

Interview with Mr. James Bradbury
Centre for Additive Layer Manufacturing, Exeter University
5 February 2014

- Katy Connor [KC]
- James Bradbury [JB]

KC
Could you please introduce yourself and say a little about what you do?

JB
My name is James Bradbury, my job title is CALM Coordinator and Research Fellow.

[redacted]

So how CALM was created or formed was to support businesses across sectors, to enable them to learn about Additive Layer Manufacturing (3D Printing): to enable them to adopt it, to learn more about it, to be able to take advantage of the ability of the technology and hopefully to incorporate it into their business or into their work.

So really the last three years we've very much focused on trying to do that, so we've worked with every company you could imagine; so companies such as pharmaceutical, medical, aerospace, space, defence, marine, art and the creative sector, the food industry – literally every sector you could imagine!

We've mostly focused on the product development side of things; because the technology lends itself to being quite a useful tool to be able to come up with new ideas and to produce something physical, easily (in most cases!) So that fits really nicely with how most businesses run regardless of sector, as far as in how they can use the technology.

That's certainly the core of how the Centre started or where our objectives are, and we've now completed over 200 - coming up to 220 completed projects - with separate companies and sole individuals over the last three years, so its quite a diverse range.

[redacted]

KC
So your actual day-to-day job is quite wide in scope: to be personable but also needing to have a handle on the technology?

JB

[redacted]

[redacted]

KC
Wow (laughter) I'm really interested in your background, where you came from, your experience and education?

JB
[redacted]

[redacted]

[redacted]

[redacted]

KC
So it was used more like a prototyping tool?

JB
[redacted]

[redacted]

[redacted]

[redacted]

[1] Alcoa Howmet (2014) *Alcoa Howmet* [online] Available from http://www.alcoa.com/howmet/en/home.asp [Accessed 7 February 2014]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

KC So did you get chance to feedback to the people who were actually designing the AM machinery?

JB
Well yes, because Airbus is a large prime within the Aerospace industry they were always, very much involved with pushing the technological boundaries forward, so it was very easy. Well, they came looking for us to be perfectly honest!

We obviously wanted to be very active with new systems manufacturers, new material developers, and so-on and so-forth, to really understand what is possible and required for our needs (as in Airbus' needs).

So we worked a lot across the whole scope, and I guess that's where I got my broad understanding and knowledge all the types of processes and all the types of materials there, because part of what we needed to understand is, "what is available?", what we can and cant do, "what are the challenges?", "what are the gaps, the knowledge gaps?" and "how

[2] GKN Aerospace Europe & Special Products, Filton, Bristol, United Kingdom GKN Aerospace Europe (2014) *GKN Aerospace* [online] Available from http://www.gkn.com/aerospace/aboutus/Pages/what-we-do.aspx [Accessed 7 February 2014]

does this fit into the future for Airbus?" So we were very actively working with everybody in the whole sector of Additive Manufacturing.
But it's surprising because then, the sector of Additive Manufacturing was quite a small sector. It's growing but then there were no more than 400 people in the whole of the UK who were actively working in that area for over 10 years. I mean, I'm sure it's quadrupled plus in size since then, but I'm only talking 8 years ago so that's quite a large increase in interest and people involved with that side of things.

So what happened then, in 2009, is that we realised we were actually being restricted, because we sat in Airbus and EADS who own Airbus (they also own EuroCopter and Astrium, and Cassidium and lots of other businesses as well[3]) and they realised that this technology could be applied to other areas of their business, not just civil aircraft.

One of the real challenges that we faced sitting in Airbus, is that because it was civil aircraft (there is military but the focus is civil) they have the most stringent, qualifying high standards to actually get anything in place, at the top end is it's too hard to get a new technology in place.

So moving into EADS (we still stayed in the same building but just moved our research table form one part of the building to another) what that meant was that we were able to look at *all* the business units, and because its such a diverse range of different sectors, and more approaches gave us more scope, it meant that we were able to look at things like Space, where the requirements for that instead of civil aircraft were a lower entry level, as the risk to human life is obviously less, and that is safety critical.

[redacted]

[redacted] in 2010 CALM was formed. Part of what EADS wanted to do, as part of their strategic vision moving forward was - they rely heavily on the supply chain to support their businesses and with this new technology coming onboard they were concerned. One of the driving factors is that they wanted the supply chain to be as knowledgeable as possible within this area of 3D Print / Additive Manufacturing, which would in turn then better their company, their product and so on, so it was advantageous for them to do that.

Part of CALM's objectives (as I mentioned right at the beginning) was that EADS saw that as being a real benefit to them, so that's why they became strategic partners and financially funded CALM at the start to enable us to be part of that.

So in 2010 CALM was successful in as far as 2.5 million pounds – 1.5 million of that was government funded money so 60% of that roughly and the other million pounds was from the University and EADS, so that's how it was split, so quite substantial amounts of money.

And the money was used to basically build the Centre, recruit the team, buy new equipment and fulfill the objective of working with businesses across all different sectors. So I guess the philosophy of CALM and how it works very much came from the research group in Airbus; how that evolved and developed, and then went to EADS. So they've very much taken that philosophy and then applied it outside to other sectors and so on and so forth. So that was in 2010.

[redacted]

[3] EADS are the parent company of Airbus.
EADS (2014) *EADS* [online] Available from http://www.astrium.eads.net/ [Accessed 7 February 2014]

[redacted]

KC
That's really interesting - the history of that kind of research, coming from private sector investment and wanting to open out into other fields, as they can see the potential…

JB
Yes absolutely, it's a really good way of using the money; taxpayers' money at the end of the day should be spent most wisely. The feedback we get from a lot of the work we've done has been positive, they've all said that it's a really good use of public money; to use it to boost the economy and bring it back to the social environment and public realm.

KC
Yes, and I imagine that in this region it's been incredibly beneficial, as its very diverse, its more rural - I mean it's not simply London-based -

JB
Yes absolutely, the South West has got a strong Aerospace background, so they were very interested in that but there's also a huge range of other sectors, as you said, the South West as a region is really very diverse, and I think they realised that using this technology in such a diverse region could be really beneficial.

KC
So you really have seen, first hand, the development of the technology over the last 8 years or more

JB
Well yes absolutely, well since 2000 really - which is when I was introduced to it. The technology started back in 1987 with the first system, stereolithography SLA[4] - that was the first technology in the US, and then basically from there it's expanded to become all these types of processes and technologies.

So I kind of came quite late! 2000 was quite late in the sense of when the technology started, but the last 14 years has been such a dramatic increase in development in this field, it's been quite scary actually.

Now we're hoping that we'll keep up with the demands and expectation of the technology, even though its still a really interesting technology and field to work in, but because more people suddenly know about it – you know it's on the BBC everyday and the range of possibilities is so diverse! I think people kind of naturally - because it's there, everyday you see something, your expectations become a lot more - whereas in reality it's only been in the last 10-15 years that the technology has really evolved.

KC
Yes I'm quite interested in that cultural 'bubble' around 3D printing, so it is seen as this way to solve everything – you know even environmental or ecological crises…

JB
I think the really nice thing about it, is that it's a different way of working; it's a different philosophy and you can apply it in lots of different ways, so I think that people are really interested in how they can use the technology to best benefit them, and like I said it's an additive technique where you add material rather than remove it. And because of the ability

[4] Developed by Charles W. Hull it used a technique called *stereolithography*, in which a UV laser is shined into a vat of ultraviolet-sensitive photopolymer, tracing the object to be created on its surface.

PCMag (2014) *3D Printing: What You Need to Know* [online]
Available from http://uk.pcmag.com/3d-printer-reviews/74222/feature/3d-printing-what-you-need-to-know [Accessed 7 February 2014]

to be able to theoretically come up with something that's in the digital form - we're in a digital age now - so it fits really nicely with that.
I guess having a digital form or object and then being able to build it gives you a lot more scope to be able to come up with new ideas, now that there's more digital software and that has evolved massively as well. Because, you've got to think that without the digital software and the ability of the IT side of things - without that, this technology becomes, I wont say useless but it becomes less useful.

So I think it's really benefitted that there's suddenly these new ways of designing, developing and creating things through digital means, and that's had a real positive influence on using this technology and I think we probably take that for granted.

KC
Yes I guess actually, thinking about it in 2000 the computer software would be quite limited compared to where we are today…

JB
Yes very basic, absolutely, so both have coincided.

KC
We've talked about this already, but do you think that ALM, like they say on the BBC, is a revolutionary tool? Is it going to change everything? Do you agree with this, or do you think it will work alongside other methods? How do you see the scope of how it will change?

JB
Well. I think the more people get involved with it, the more people have an input, the more it's going to evolve quickly and in different directions. I mean, you've got what we call the low cost systems and then the higher manufacturing cost systems.

The one thing that will be a bit of a catalyst, as far as this technology's concerned is the lower-cost systems, which are the ones where you're not talking about hundreds of thousands of pounds to purchase these machines, but suddenly you're talking about a few thousand or even a few hundred – those that have started coming out in China.

KC
Yes, the more domestic scale?

Absolutely, and then suddenly the hobbyist or the everyday person can start having these, coming up with these new ideas and designs and things and have access to this equipment that could potentially be in their home or whatever. And that's only really evolved probably (the first ones came out in 2003/2004) and that was the very first ones so really it's only the last 10 years that the lower cost systems have developed. But they are coming on leaps and bounds, because I think actually that a lot of people are really interested in it and as that develops, I think that has really pushed the technology forward.

All these stories you see on the BBC, or on the general channels, are often are based around the lower cost systems. There are some really nice case studies that people have made with the higher-cost machine systems, but the everyday things that you see on the BBC or national news (or whatever it happens to be) are often the lower cost systems, and that's why I think that it's made a huge influence on this technology - who it's going to really attract and which people can be involved with it.

Then you've got high cost manufacturing which, from an industry and engineering point of view, that's made huge influence, suddenly you've got all these businesses turning round and going, "actually we can use this as a manufacturing method because of the ability to design new, more functional, flexible free-form objects that are more efficient than current ones", so that's from a business point of view, from industry.

So really, you've got two totally different people, looking at the same subject differently, that's why I do believe even though we do look at the

low cost systems and snigger and generally see it as some sort of a rip-off, then really we're comparing it to the manufacturing systems that obviously are totally different to the lower cost systems. But actually the low cost systems in their own right have opened a new door to this type of technology and the people who use it. For example the Chocolate ALM[5] is all based around the lower cost systems and all these ones you see in the home, and this very controversial thing about the 3D printed gun in the US recently[6] again that was done using a low cost 3D printing technique.

KC

So its like a two-tier system, you've got the more domestic, almost like the Maplins[7] kind of version, and then you've got the high-end industry who are, I imagine putting a lot of money behind developing this and using it in manufacturing, almost like a bespoke manufacturing tool rather than going mass…

JB

Yes absolutely - so its quite interesting those two types of people…

---

[5] CNN (2014) *Hershey's to make 3-D chocolate printer* [online] Available from http://money.cnn.com/2014/01/16/technology/3d-printer-chocolate/ [Accessed 07 February 2014]

[6] BBC (2014) *Working gun made with 3D printer* [online] Available from http://www.bbc.co.uk/news/science-environment-22421185 [Accessed 07 February 2014]

[7] The popular high street electronics specialist store has recently introduced a range of domestic 3D Printers, available to purchase from between £700 to £1700.
Maplin (2014) *3D Printing* [online] Available from http://www.maplin.co.uk/3d-printer [Accessed 07 February 2014]

KC

Have you seen how the use of materials has changed over this period of time? So now, I know there's a lot more scope with the kinds of resins or plastics – but what was being built previously?

JB

Yes. In reality if we go back 15 years, when I was first introduced to the technology, well, metallics didn't exist, none of the metallic alloys existed. Polymers, you only had UV Curable Thermosets and only 5 or 6 of those. They were developed especially for certain applications. Then you had wax printers and with the polymers, you had purely nylon material, so it was very basic. And the reason why they were chosen, primarily, was ease of processing, as those types of materials are really very easy to process using this kind of technique, or that those particular materials were specially made, because there was a particular person who was willing to pay and wanting a particular material.

Suddenly now you've got close to 40 different metallic alloys available, the polymers and the interest in using this technology from a prototype point of view has suddenly expanded - so you've got Polypropylene and PTFE - you've got a huge range of plastics now have suddenly appeared, that wouldn't have been there before. And then you've also got the area of environmentally friendly, biodegradable materials, more like PLA; more ecofriendly materials that have suddenly started; three years ago they never existed.

So the metallics have only developed in the last 6 years, the other range of plastics probably within the last 5 years and the bio in the last 3 years. So you really are talking about things that are only happening recently – but there has been such an increase in interest and the huge range of what's happening with it – that's really what's sparked all of this semi-new development, and at the end of the day it's money and interest that will push where the technology will go.

KC
So do you think its private industry that has pushed this expansion in materials, just referring to this two-tier system?

JB
On the metallics, that's private industry purely because the systems are all high-cost so that's very much driven by that side of things. Saying that though, you've got people in the jewellery industry doing that too; but that's more a manufacturing of a particular product. It might be for the jewellery industry but it's not the everyday person who walks about the street so to speak.

The range of other polymers, that is probably a mixture; because some industries want more polymers that they're familiar with, that they'd like to develop themselves, to develop their product, but also those naturally fall into the cheaper systems, so the expanding range of cheaper systems has probably pushed that as well.

And the environmental eco-ones; in reality, those have developed because of all the regulations, so there's been a real push from the EU and further afield to be able to really reduce the amount of resources; we're running out of resources at the end of the day, and we're struggling - oil's becoming more expensive – and we're digging and using as much of these raw materials as possible. So to actually come up with new sustainable materials is a huge area as well. And I think a lot of that is driven by – well, the good thing is that's pushed by the Research Institutes as far as the funding for those longer sustaining things is seen as really important – a lot of the research is driven by the long-term aspirations of the technology.

KC
I was just thinking about the process, of actually going from the CAD design and going into the manufacture, and I'm interested in your perception of that because it's something that this project has thrown up for me. So I'm interested in that relationship between designing something virtually, and it existing digitally (in a 3D virtual environment) and then translating that into a 3D material object.
And whether you, from your experience, whether you'd found before that that was a tricky process, or whether it always seemed quite straightforward?

JB
The actual process itself - because this technology can't be used without a digital form of the object, it's always been a known requirement that you have to have a virtual object of some description, and then you can use particular bits of software to slice it up layer by layer and put that slice data into the machine to be able to reconstruct your object. That's fundamentally the technique right from the late 1980's, so using that particular philosophy has always been there.

But it's very much the tools, being able to come up with those objects, the software that enables you get more control and better slice data, to the actual hardware itself; to be able to produce objects that are more 'realistic' in their physical form, compared to their digital form; so like the features and definitions and details and those sorts of things; there's a hardware side of things as much as a software side to things, so there's a huge range of things. But the actual process is quite well established, even though perhaps the tools and the level and the ability and flexibility to be able to do extra things has certainly come onboard in the last X amount of years.

I think with your particular project, the really interesting and challenging thing was not just using CAD, but taking the data that you had been able to obtain from your AFM and using that; how you had to convert that digital data into a form that you were able to then produce physically. Because you're talking about the detail, about the magnification; literally all these challenges that we had, to be able to come up with your final, physical object was using that philosophy.

So rather than just coming up with using a Computer Aided Design, a CAD software package, and just coming up with a design onscreen -

actually that's the simple approach compared to what we had to do with yourself. So really it was a different approach, certainly at the beginning anyway.

KC
I know you've said that you've worked a with a lot of different sectors and I know that we started this project through the Exeter Phoenix project - is that the first time that you'd worked with more "creative" artists?

JB
Yes it was, yes – absolutely! [laughter] It was indeed yes.

KC
And how did you find that process?

JB
It was an eye-opener! Engineers are very methodical, logical, straightforward sort of people. We learn - Engineers learn - to follow the rulebook more than perhaps open their mind to possibilities. Luckily being part of a research group at Airbus enabled me to be perhaps, a bit more open-minded, and certainly my role within CALM, to work with different sectors and work with people with different philosophies, has certainly improved that aspect of me.

But absolutely - a perfect example of the Exeter Phoenix exhibition project where I was introduced to you - was, I think we were talking about "surface roughness". Some of the engineers see the surface roughness of some of the parts we make as being quite rough, quite poor, compared to say machined or injection moulding. Where the artists saw that actually the texture you get on the surface is quite intriguing and quite interesting – so again it's seeing something and yet having two different views, perceptions - yes the perception is totally different.

And in manufacturing and engineering you look at repeatability and quality control; trying to get things the same again and again and again. Where the artists, the creative guys really wanted unique, different – the opposite to repeatability really! Which again was a totally different perspective and way of thinking!

One of the artists was really interested in the process that we used for yourself, "Laser Sintering", which is a thermal process where you have to heat the powder up. Because of this you need to be quite controlled with the temperatures in the process, whilst you're building -and before and after as well. And one of the things is, if you don't control that cooling rate you start to get distortion and warping, which for a feasibility and manufacturing point of view is a no-no. But one of the artists was really fascinated with that because actually, you suddenly realise that you're able to twist and warp and change your geometry to something unique and different that perhaps you wouldn't be able to get any other way.

So again those are two or three examples, of totally different ways in which you see it in relation to the creative industries I'd say.

KC
Could we talk more specifically about this project, as there's been quite a few challenges, and I just wondered from your perspective if that process has made you think more widely about the process that you're using – or made you more aware of your own methods? Or if it has opened you up to other ways of using or approaching the technology?

JB
The really interesting thing is that the challenges, even though I've said a few things there about how the creative (industry) person or perception is different to a manufacturing perception; a lot of the challenges or requirements are actually quite similar in the sense of "what type of resolution or detail can you get in a particular object?" or "what are the constraints or the ability of the technology?" – so all these sorts of

questions are a kind of general knowledge, that needs to be understood regardless of how you plan to use the technology.
I think certainly as regards your particular project, it's pushed the boundaries of what the technology was certainly able to do, because like I said, taking something and magnifying it by was it 500 times?

KC
Yes the original sample was 0.05 mm – so then we had to scale that up.

JB
Yes, so I think it was close to 500 times that we had to scale it up; and we talk about scaling in manufacturing but we're talking about things that are perhaps a metre long, but the object is *designed* to be a metre long necessarily, or *metres* long.

So, what we were doing with you was taking a sample, an object - your piece of work - and scaling that up by 500 times *plus*. And then trying to understand, "what are the challenges behind that" because naturally, your data, your geometry that you supplied us was a scan - it was an OBJ [file] - it was a scanned object.

So to be able to convert that into a thickness, as it didn't have a thickness, so we had to give it that third dimension (as obviously everything has to have a third dimension if you use 3D Printing / Additive Manufacturing); then to be able to scale up *that* component, to be able to then *build* the features that were required, that was the biggest challenge.

So, then the other challenge was that the file sizes became huge, because of the amount of data that was involved and the detail and the amount of surfaces that you had on your scanned data, suddenly you had this file size that was humungous (!) compared to what we're normally used to!

Because we had to scale it up and do all these modifications, suddenly, regardless of producing the part - just purely the software side of things – the digital challenges that we faced to get the digital representative of your scan to something we could build was a challenge in itself.

KC
Yes – because I remember at first the ambition was to build the whole thing -and then we split it into quarters – and we only managed to build two pieces because the detail was too fine, and the machine couldn't cope with the detail. So then we started scaling it up further and just taking a smaller section…

JB
Yes, so we had the software challenges, which is what I've just said - the digital challenges - then we also had purely the physics of the system and how the hardware works and how the process works, and trying to understand "what are those limitations or requirements" and how does that fit with your part - with your scanned data.

And that's where actually then that becomes very similar in terms of the types of challenges you can get, *regardless* of what the object is, because the object then becomes – it doesn't really matter what the object *is* - the challenges are still the same as far as trying to produce an exact replica of your digital data. You'll try and understand what the hardware can do for you.

And like "feature definition", where one mm was the minimum wall thickness, so we had to create that, and because of the size constraints we had with scaling it up, we then realised that actually it would be impossible – or shall we say - very time-consuming and costly to be able to produce a full scale version of a 500x application (or plus) of your work.

And the other thing - because what happens is that, when you scale up an object that extreme and then you try and give it a thickness - you've got all this data and the surfaces intertwine and they get very confused and then you put it into a piece of software that slices it up.

Well, what happens is that it slices every layer and identifies any problems with this data, for example "open surfaces" (because it needs to be a sealed surface you know) and it looks at all the other features and requirements, and if there's any problems then it deletes that object, that geometry, to make sure that it can build your part up.

So you have to be wary that if the data is too bad (i.e. not good) it will delete so much information that actually then, suddenly you have missing *layers*, and missing *details* … and they were the things that I was really concerned about for your work because if it deleted too much of it then suddenly we wouldn't have a true representation of your work. So a lot of the challenges were based around that, more than anything else.

KC
So its almost as if the machinery, the computer has its own agenda in a way, you're trying to work within the limitations of that, as it has its own methods of compensating-

JB
Absolutely – yes there are certain ways to get around that but you have to work like that-

KC
So I'm taking from this that that's not a usual way of working?

JB
No. Purely from where your project's concerned, what we've learned here is that a lot of the interest around this technology is not just about designers coming from a conventional CAD, and then slicing that data up and producing an object - that's the most commonly used method.
But actually, as we spoke before, this area is becoming such a diverse and widely used process, industry and way of working that *actually* there are going to be many, many ways of being able to capture that data - and the more ways there are, the more new ways there are going to be to use that technology in some shape or way, but of course that means there's going to be new challenges.

So the really exciting thing that I saw about your particular project, is that it took an original digital data file – and it was something that was unique, new and not *norm* - not the normal.
Having the challenges (as I've already explained) to try and get to that point and then try and understand how we can make it as well.

So how I see it, is it's a really interesting way of trying to understand "what are the limitations, what are the challenges currently with this particular process" and the software side of things as well – because I envisage that in the future, like I said there's going to be more people coming up with different ways of using this technology - it's inevitable that its going to be more of these scenarios – like for yourself, in the future.

KC
Do you see that feeding back into the actual technology, the machinery or the software?

JB
I think less on the hardware, because in reality the hardware is evolving and changing anyway. So one of the things that we've got is that you buy a standard machine, and it will produce parts of a certain size and certain resolution and quality.

Now, the perfect scenario is that you'd have this machine and you can build parts in Nano and micro size with particularly fine details all the way up to metre-long structures, and will build them in hours rather than days. That will not happen – well certainly in my lifetime – and certainly as far as the here-and-now is concerned, it will not happen.

What you get is a machine that has a particular size, detail and certain restraints and they will evolve and change, but what's happening is that probably you will have to use a certain machine and design for your

particular geometry. So you will have to work with the machine that fits your requirements.

KC
So one machine for more medical uses?

JB
Yes because the types of scenarios for that are similar, compared to another scenario -

KC
Maybe like architecture, where you're building on a bigger scale?

JB
Yes, a bigger scale where the challenges are different… and I think that will always be the case. Everyone wants a machine that does everything, but I don't think that that's practical to be perfectly honest. But that's happening already.

So I don't think your project will necessarily change *that,* because that's already happening.
But I think what it will do is, *certainly* it's a really nice way, from a software point of view in realising what you can and can't do with it, and what must be improved – to enable it to become an easier process to use it in the future.

KC
Is there anything else you'd like to add perhaps?

JB
The really nice thing about this technology, and the advantages are that it enables you to build new shapes, strange shapes, interesting shapes, intelligent shapes. Basically to be able to change the way in which your mind works as far as the physical object itself, regardless of your need or requirement or what your reasoning is behind it – and that philosophy is really nice.
So to be able then, to take something like your AFM, that's captured in a certain particular way, so it has a particular object feature and to be able to create that, is one way in which we're using the technology to get what you want – your requirements.

One of the real exciting things about this technology is that – (and I always go back to this, I'm one of these people who see this technology as being used for more organic, free form, more natural structures) and I see the potential of this technology to be able to come up with more naturally evolving shapes and objects – because they are better than our current methods and ways in which we visualise, think and can produce objects. *This* is really exciting to me.

I think your scenario, using your data, and the structure that these peaks, the structure that you get; if you've got a scenario where you can capture data, capture something where you can potentially - you can actually use it - then it becomes quite exciting.

So, like for example, bone structure - where you have the internal structure of a bone, it is actually quite foam-like but it's naturally evolved, changed and developed for its requirements. Capturing that data is one thing, and then suddenly – you'll have the same scenario that you've got – where the resolution, the thicknesses, changing the data, modifying the data… this then becomes actually a similar challenge to what perhaps we had with you.
And then being able to take that form and then create, being able to create a form where you can be able to manufacture that – build it – is again, the next step.

So for me, I think that your example, of taking something that isn't the norm i.e. that isn't a digital form that's been designed. (Fundamentally CAD – Computer Aided Design - has been designed to come up with basic shapes and objects to be able to come up with something that you're trying to build.) Whereas your data was not created for that

purpose, so taking something that is totally different and *still* being able to do something with it and create something with it - that's exciting!

KC
I guess when we perceive these things, on that scale – that's when we start learning about the world around us; taking natural forms and starting to perceive the world around us and how different things actually are?

JB
Yes I agree, absolutely.

KC
Great! Thank you

JB
I mean to answer your question about being a revolutionary technology or tool or manufacturing process, I think it will have a huge impact on certain industries from a manufacturing point of view, and I think it will potentially have a large impact on life for the everyday person.

I don't think we're there yet, as there's still a lot of development. Because people can't really see what it can be used for in the best way, it can be this "thing" – this revolutionary technology that can do everything – but actually what I think will happen is that there will be certain things, over perhaps the next 5-10 years, that will come out that actually will be revolutionary and will work with the technology – and there'll be things that it won't really affect.

I think we're in this time period, over perhaps the next 5-10 years, where that will happen.
But I see it as a tool to be able to be used differently to the other ways that people think and learn and use things - from a manufacturing point of view, there are other ways of manufacturing things that we've done for hundreds of years, and the reason why is because it's the best way to do those things! This [AM / 3D Printing] isn't necessarily going to be the best way to do everything, it's going to be a good way of doing some things, so it will be a complimentary part of those options. So that's how I see it in manufacturing.

As far as everyday people, actually it really is driven by *the digital world* – as far as I think that has a huge influence on actually where ALM will go, how much it will really affect the everyday person, as far as what you can really do with it.

KC
What do you mean by *the digital world* – do you mean software?

JB
The software side of things but like the internet, that has changed so many people's lives because it is so powerful. This technology has the potential to be – I wouldn't say *that* powerful - but it's driven by what people can do with the digital side of things, and then use the technology to produce it.

KC
My question comes from this kind of hype that states that 3D printing is going to change the world; i.e. everybody has heard of it, and its going to be the next Big Thing. And that's all kinds of figures, from those who've invested a lot of money in it (although they obviously have a vested interest in saying that it will change things …)
I suppose the way I'm thinking of it is that 20 years ago, Nano-technology was the next Big Thing, and there was a lot of hype and imagination and speculation - and I'm trying to work out what is the hype, and what at a pragmatic level, is actually going on?

JB
Well hopefully if I can give you a more pragmatic, ground-level perspective of what's possible, I think what you have to remember is that

if you look at the figures and the numbers – other ways of making things, even *the digital world* as we know it has evolved over decades. Whereas this technology has developed over less than 30 years, which if you think about it you're only talking about the last decade when things really started happening.

So in reality we're a 2 year old trying to live in an adult world scenario, so its really difficult to be able – you know all this responsibility and expectation falls on a 2 year old – and its very difficult to be able to know what's going on!
So that's why, you can say its revolutionary and it will change everything but that's a little too wild, I would say – but to say it will just peter out and it's all hype is perhaps wrong as well – and I think its probably somewhere in the middle to be honest. That's my personal opinion anyway.

KC
I just wanted to explore a little more the difference in approach between a manufacturing company who say, want to develop a particular component, and an artist who wants to perhaps scan the surface of water – just the difference between these approaches?

JB
I think actually my previous examples of the differences in perception; I mean in regards to the manufacturing company versus the creative types, everyone asks the same things, but perhaps for different purposes. So, "Can we can something?" or "how do you capture that data?"
Everyone asks the same things but the *what* and the *why* (and its more those *deeper* questions) I mean the question about the scan of moving water, it's an amazing concept and idea but …

I think what one of the nice things is actually the creative types were asking questions that are more challenging than the manufacturers. And I say that not simply because I'm used to talking with manufacturers and I'm used to what they ask, so I'm used to what their answers are going to be, but it could well be that the processes and the way it's developed is very much by engineers, by manufacturers for that purpose. Whereas the creative types are asking questions based on something that's new to them – and no one's ever really thought about that or ever needed to think like that because its never been used like that before. So I think it's more down to that approach…

KC
So testing the limits?

JB
Absolutely – so because of that, the creative types' questions were actually harder than the manufacturers, because they're thinking about something that's never been used before – and that's quite interesting.

This is where a lot of the Research Councils are trying to develop these cross-disciplinary approaches, because I think they realise that if you get an engineer sitting next to a creative artist, talking about a particular area, they're going to approach it from two totally different sides. But actually both are going to be equally as interesting and equally challenging but for totally different reasons – but both have the potential to improve whatever they're talking about.

So I'm excited about working more with the creative industry to try to challenge this technology and have an influence on where it can go, and your project is a perfect example of this, and yet touching the tip of the iceberg as far as asking questions … but just imagine hundreds of thousands of people like you, constantly asking those types of questions – it would be really quite exciting.

END

Katy Connor
8 Windmill Hill
Bristol BS3 4LU

+44 (0) 7968 690461
info@katyconnor.com
www.katyconnor.com

Studio
Spike Island
Bristol BS1 6UX

born, Gorseinon 1973

EDUCATION

2011-2016	PhD *Experimental Media Research*, Bournemouth University
2007-2009	MA *Contemporary Arts Practice and Dissemination,* Dartington College of Arts
1995-1997	Foundation Diploma in Art and Design, Birmingham Institute of Art & Design
1991-1994	B.Soc.Sc. (1st Class Hons) *Media, Culture and Society,* The University of Birmingham

SOLO EXHIBITIONS

Zero Landscape Test Space | Spike Island and The Control Room, Redcliffe Bridge, Bristol 2016
Sculptural objects and print works that consider the body's spatial positioning by both medical and geo- locational technologies, to reflect on the mediation of global and interior landscapes.

Pure Flow 2.0 Plymouth Arts Centre 2011
Work exploring the poetics of data visualisation, navigation and digital displacement
Installation, sculpture and print work, made during residency at iDAT Plymouth University

Pure Flow 2.0 Permanent Gallery Brighton 2011
Launch of *Pure Flow* as a mobile APP for smartphones: part of Brighton Digital Festival
Public artwork - projection visible 24 hours a day for the duration of the festival

Untitled_Force Test Space | Spike Island Bristol 2011
Work made during iDAT residency, exploring the poetics of data visualisation
Supported by Spike Island Associates.

Pure Flow Exeter Phoenix 2009 Digital media installation
Light-based and sonic environment, visualising the data fluctuations between satellites and a stationary GPS device, as poetic static. Software programmer Dr. Duncan Rowland
Shown with supporting video works, sculpture and drawings
Commission awarded by Exeter Phoenix Digital Media Art Bursary

Bound The Herbert Coventry 2007 Four screen Audio Visual installation
Moving image work exploring the biological bond between mother and child
Made in collaboration with choreographer Andrea Barzey and sound artist Helena Gough
Supported by Fracture (Dance on Screen) and Arts Council England

Afterglow VIVID Birmingham Centre for Media Arts 2007
Video collage exploring Spaghetti Junction: as a site of leakage and striated space
Made in collaboration with sound artist Helena Gough
Commission through the Interdisciplinary Support Programme (ISP) 2005-2007

Aureole The New Art Gallery Walsall 2005 Multi-screen Audio Visual installation
Moving image work exploring mediated choreography and medical practices of foetal scanning.
Made in collaboration with dancer Andrea Barzey and sound artist Helena Gough
Commissioned by Capture. Supported by Arts Council England

Katy Connor CV

SELECT GROUP SHOWS

2015	*CONTACT /SURFACE,* Exeter Phoenix: Artists commission with Double Elephant print studio. *ReDefining Print* Symposium, Catalogue and Edition Print.
2013-14	*The Lumen Prize* Exhibition, International Tour: New York Institute of Technology, The Space, Hong Kong, OCC Athens, Chelsea Space London, ArcadeCardiff
2013	*Transmediale* Berlin: Exhibition and Performance: Curator Jacob Lillemose
2013	*3D PrintShow,* Exhibition: 3D Print Industry and Design Conference, London. Curator Carmen Salas
2013	*Generative Constraints,* Exhibition, Royal Holloway and Kingston Universities, London
2012	*The Right to Know (and Copy)* IMPAKT, Netherlands: Curator Sabine Niederer
2012	*NeoReplicants* Exeter Phoenix: 3D Print commission: Curator Matt Burrows
2011	*Performance Studies International,* Utrecht, Netherlands: with Ayara Hernandez Holz
2011	*Y Lle Celf, The National Eisteddfod of Wales*: Curator Alessandro Vincentelli
2011	*Three Corners of a Triangle Squared,* Spike Island, Bristol: Curator Sacha Waldron
2010	*Salon Video Art Prize,* Matt Roberts Arts, London: Curators Mike Sperlinger and Zineb Sedira
2010	*Tipping Points* HBC, Berlin: Curator Bill Leslie
2008	*Dance Film Festival,* ZAIM Yokohama, Japan: Curator Naoto Iina
2008	*WHIPPIT* Elevator Gallery, Hackney, London
2008	*1,442,666 Schritte*, Frankfurt, Germany
2007	*Concrete Cannot Stop Them*, BBC Big Screen / Radio 3 Festival of Ideas, Liverpool

RESIDENCIES

2015	*The Arctic Circle*: Art and science expedition to the Archipelago of Svalbard, Norway 3-week research residency. Selected by International Jury.
2013	*OUTLANDIA* Remote Artists Field Station, Glen Nevis, Scotland Selected by London Fieldworks and Tracey Warr.
2011	*Synthesis:* Synthetic Biology Exchange Lab. Arts Catalyst, UCL, SymbioticA 10-day intensive. Lab-based practical workshops, discussions and events.
2010-11	University of Plymouth, Centre for Interdisciplinary Arts & Technology (iDAT). 12 months Lab-based workshops in Atomic Force Microscopy and Bio-data visualisation.
2008-09	*l'Animal a l'Esquena*: Centre for Body-Based Practice and Research, Celrà, Spain. 6 months Workshops, labs and work space.

AWARDS

2013	Lumen Prize - Shortlisted Artist (International Jury Panel)
2013	Santander Mobility Award to develop 3D Print work with Exeter University
2011-15	Arts & Humanities Research Council: PhD Research (Full Funding)
2011	Arts Council England: Grants for the Arts
2007-09	Arts & Humanities Research Council: Masters Research (Full Funding)
2007	Arts Council England: Grants for the Arts
2006	VIVID Birmingham. Research visits to *Ars Electronica* and *Transmediale* Berlin
2005	Arts Council England: Grants for the Arts

PUBLICATIONS

2015	*Remote Performances in Nature and Architecture*. Ashgate. Cover Image
2013	*Translating Practice:* Journal of Writing in Creative Practice, Intellect Books: Vol 6, issue 1
2012	*From Solid-Light to Satellite: the Moving Image as Broadcast Signal and Data* Published by e-permanent gallery, Brighton Presented at *The LUX Biennial of Moving Image,* ICA London
2012	*LIVENESS* (Editor) Author Sally O'Reilly, Experimental Media Research Imprint
2011	Artist Interview: BBC *Click,* The World Service
2011	*Human Geography v1.0 BiOs*. iDAT and Liquid Press
2008	*Desiring Machines.* Review by Dr. Mark Greenwood. A-N Artists Newsletter
2009	*Pure Flow* Exhibition catalogue. Essay by Dr. Mark Leahy

Appendix 8: *BU Santander Grant* Applications 2012-2013

Santander PGR Grants – Application Form

November 2012

Santander are offering 25 x £1,000 grants to BU Postgraduate Researchers (PGRs) to travel to at least one university from either the UK Santander Universities Network or one of the Overseas Santander Partner Universities to undertake a specific piece of work or develop links with international researchers.

To apply for a Santander PGR Grant, please complete the application form and submit it by email to the Graduate School (email: graduateschool@bournemouth.ac.uk) by 5pm on **Monday 14 January 2013**. Incomplete applications will not be considered. The application form must be completed as follows:

- **Sections 1-3 by the PGR**
- **Section 4 by the Supervisor**
- **All parties must sign Section 5**

Applicants will be informed of the decision by the Graduate School, normally within four weeks of the deadline and all funds must be spent before 31 July 2013.

Section 1 – Applicant details		
Student number	4427639	
Full Name	Katy Connor	
School	The Media School, Experimental Media Research Group [EMERGE]	
Date of Registration	2nd October 2011	
Mode of Study	☒ FT	☐ PT
In receipt of BU Studentship	☒ Yes	☐ No
Section 2 – Activity details		
Title of Activity	"Untitled_Force": Research, Development, and 3D Print Manufacture	
Start date	25th February 2013	
End date	28th June 2013	
Santander University / Universities involved	EXETER UNIVERSITY	

Total funds sought	£1,000 **(up to a maximum of £1,000 is available)**

Section 3 – Case for support

Detail of activity (maximum 350 words) – include detail of activity, context in terms of research project and personal development, etc

As a Practice-based PhD student, my research investigates the materiality of digital processes; through practices of making, critical analysis and reflection on production in the field of contemporary media arts. Through research outputs and public exhibitions, my artistic research introduces audiences to innovative and novel ways of understanding digital technologies. These works, together with the written analysis/exegesis, question how technologies frame, model and structure our perception and understanding of the natural world around us.

I am applying to the Santander Bursary in order to undertake a specific piece of collaborative work with Exeter University, in the College of Engineering, Mathematics and Physical Sciences. This will enable me to develop links and partnerships that I have formed with the researchers there, and to develop a key strand of my PhD research project. The monies will enable me to travel to Exeter, in order to further investigate the latest digital technologies used for industrial manufacturing; '3D print' at Exeter University's Centre for Additive Layer Manufacture (CALM).

My particular research project, "Untitled_Force" is a project in three stages. Started in 2011, it investigates three digital methods of measuring, image-making and modelling that are used in the medical, scientific and industrial fields: Atomic Force Microscopy (AFM), CAD (Computer-Aided Design) and Additive Layer Manufacture (ALM). The original material used for this scan is my own blood. The size of this particular sample is 50x50µm (micrometres) square or 50 x10-3 mm (absolute size). My proposal for the Santander Travel Fund is to develop the third stage of this project: ALM, which I initiated in August 2012.

Working in collaboration with specialist engineers James Bradbury and Richard Davies, we have modelled, tested and created an initial prototype of the scan data. At this initial stage however, it has only been possible to print a tiny fragment of the scan. [See attached image: KatyConnor_Santander1.pdf] This 3D print is less than a quarter of the data, yet is magnified at 20,000 times its original size.

I now wish to use the Santander Travel Bursary to continue to develop "Untitled_Force" at a key stage in the context of my PhD research. This bursary will enable me to take my project through from initial tests prints created at the MPhil stage, to a more substantial body of work.

Justification for support (maximum 350 words) – address how this proposal will help you research project or personal development, the potential benefits and the value for money

My application proposes to cover my travel costs to Exeter University and the production costs of the prints, including materials (Polyamide12 nylon powder) and digital programming.

Based within the University of Exeter, the facilities and expertise at CALM are unique. Working as academic researchers, as well as at the cutting-edge of aerospace engineering, Formula One and Medi-tech industries, CALM has the only system in the UK capable of additive manufacturing with high performance plastics. The specialist ALM engineers have knowledge and experience gained both from research and industry (BAe, Dyson, Renishaw and architects Foster & Partners).

The detail presented in the CAD file, from the Atomic Force Microscope scan is incredibly complex: the 3D model of "Untitled_Force" has over two million facets. The build requires working with scale and precision, which presented real challenges to the engineers when working on the initial prototype. It is therefore crucial to work with these same engineers to develop the work to its highest standard.

The 3D print of "Untitled_Force" is the third and final stage of this practice-based project. Its completion will reveal a new way of modelling biological data, enabling a deeper understanding of how contemporary digital technologies are changing our perceptions of ourselves. As a Practice-based PhD researcher, the practice-

based element of the work is an integral part of the Methodology. It is only through making the 3D print, that conclusions can be drawn.

The Santander Bursary will enable me to develop my networks and links with academics at CALM, who can facilitate access to other areas of the University. I intend to meet with researchers in the field of Bio-Medical Physics and the Medical Imaging sector; Dr Sara Flint (CALM) has already suggested potential collaborators. Developing work with the very latest bio-medical imaging technology will enable me to ask further questions; of how technologies frame, model and structure our perception and understanding of the natural world around us.

Value for Money: as initial introductions with researchers have been established, time and resources from this application will be dedicated to building existing collaborative relationships and tangible outcomes. These will be used to disseminate the research widely, in both academic contexts and public art exhibitions.

Prior to the PhD, I was Artist in Residence at iDAT, Plymouth University's Centre for Interdisciplinary Research in the fields of Digital Art and Technology. My long-term goals for the future are to collaborate with academics, technologists and exhibition curators Arts Catalyst and the Wellcome Trust. This funding will enable me to start to develop these important relationships now, and thus ensure their likelihood of success.

Deliverables (maximum 350 words) – list the anticipated outcomes or outputs

There will be three outcomes:

1) The '3D Print' "Untitled_Force".

After the development of further prototypes, I expect to build at least 4 more sections from the scan data, which when pieced together, make the final work. This will be a 3D model of an Atomic Force Microscope scan of my blood. Due to the complexity and scale of the digital technologies used, the model will be magnified at least 20,000 times the size of the original material. [See attached image: KatyConnor_Santander1.pdf]

2) Developing Networks.

It is my intention to develop my relationships with existing collaborators and establish new partnerships with Exeter University, especially in the fields of Bio-Medical Physics and Medical Imaging. Face-to-face meetings, and personal introductions by staff members to academic researchers will be invaluable. These relationships will go on to provide the impetus for new projects as part of my PhD.

3) Public Exhibitions

As this research is located in the field of media arts, its main outcome will be available to the public at large, not just a specific research community, bringing an understanding of the impact of digital 3D print to a wider audience. When the initial 3D print prototype was exhibited to the public at the Exeter Phoenix Art Gallery (November 2012-January 2013) it received critical attention from the curator and many responses from members of the public. These included tweets from a science journalist working in the field of climate change (Andy Extance, simpleclimate.wordpress.com).

It is my intention to present the new 3D prints in a public exhibition of "Untitled_Force". This will be at Bournemouth University. As this research is cross-disciplinary, I am very keen to open this presentation to members of the Experimental Media Research Group, and both PGR's and staff from other departments/disciplines (e.g. Industrial Design / Bio-medical Research / etc). The discussion generated by this event will deepen and embolden my PhD research and develop networks of academic researchers at both Exeter University and BU.

I will also be presenting the works-in-progress at a public exhibition at Spike Open; Spike Island, Bristol in May 2013.

Precise breakdown of costs – include travel, accommodation, subsistence, registration costs, etc

Item or activity	Details	Cost
Travel Return train to Exeter University	6 journeys for networking, production, introductions and meetings, etc £31.50 x 6	£189.00
Travel Drive to Exeter University	For collection of model/prints Approx. 85 miles each way 180 miles x 45p mile	£ 81.00
Subsistence Visits to Exeter University	Lunch 6 visits to Exeter x £5	£ 30
Production Costs	ALM - Prints	
Exeter University - Centre for Additive Layer Manufacture Materials for test prints and final ALM/3D build	Development and production: machine costs (preferential subsidised rate) Nylon 12 (Polyamide) Powder £140 per 1000g Estimated use 2000g	£ 420 £ 280
	Total	£1000.00

Section 4 – Supervisory recommendation		
Do you support this proposal Supervisory Assessment	Yes ☒	No ☐

Assess the importance of this proposal to the individual's research project or personal development (maximum 350 words)

Central to Katy's research is an exploration of the materiality of digital forms. An area key to her work is the relationship between Atomic Force Microscopy and 3D Digital Printing. The staff at Exeter University's Centre for Additive Layer Manufacture are unique in having the skills and experience required to further explore this relationship at the required technical level. The development of this project with these technicians is thus essential to the successful continuation of her practice-based research, and her PhD as a whole. The number of trips facilitated by this funding would also give Katy a real opportunity to develop strong links with the research and technical staff at this centre. For Katy's work to progress it is essential that she gain contacts in the areas of Bio-medical Physics and Medical imaging. Through this opportunity for networking, Katy would be able to form strong and meaningful relationships with staff members with this expertise at the centre.

A small part of this funding would also support the physical manufacture of the 3D print itself. I feel it is important to recognise that practice-based researchers often have to create artefacts as part of their research process. These artefacts cost money to produce, a cost that is not recognised or reimbursed by any of the funding that they currently receive. This funding would help Katy offset some of these costs.

I would like to express my support for Katy's application for funding for this fund.

Section 5 – Signatures (applications are deemed incomplete if signatures are missing). (Add additional rows if required)

Applicant	Katy Connor	Date	12/01/2013
Supervisor	Tom Davis	Date	13/01/2013

It is the Graduate School's policy to publish a summary of awarded projects on the BU Research Blog. Please tick this box if you do not consent to this	☐

Santander PGR Grants – Application Form

January 2013

Santander are offering 10 x £2,000 grants to BU Postgraduate Researchers (PGRs) to travel to at least one university from either the UK Santander Universities Network or one of the Overseas Santander Partner Universities to undertake a specific piece of work or develop links with international researchers.

To apply for a Santander PGR Grant, please complete the application form and submit it by email to the Graduate School (email: graduateschool@bournemouth.ac.uk) by 5pm on **Friday 8th March 2013**. Incomplete applications will not be considered. The application form must be completed as follows:

- **Sections 1-3 by the PGR**
- **Section 4 by the Supervisor**
- **All parties must sign Section 5**

Applicants will be informed of the decision by the Graduate School, normally within four weeks of the deadline and all funds must be spent before 31 July 2013.

Section 1 – Applicant details		
Student number	4427639	
Full Name	Katy Connor	
School	The Media School, Experimental Media Research Group [EMERGE]	
Date of Registration	2nd October 2011	
Mode of Study	☒ FT	☐ PT
In receipt of BU Studentship	☒ Yes	☐ No
Section 2 – Activity details		
Title of Activity	"Untitled_Force" 3D Print: Development and Manufacture. Networking and presentation oppportunity.	
Start date	20th March 2013	
End date	31st July 2013	
Santander University / Universities involved	EXETER UNIVERSITY | GOLDSMITHS UNIVERSITY LONDON	

Total funds sought	£2,000 **(up to a maximum of £2,000 is available)**
Section 3 – Case for support	
Detail of activity (maximum 350 words) – include detail of activity, context in terms of research project and personal development, etc	
* Please note : this application directly builds upon research and development, as identified in the previous proposal for Santander Travel Grants, January 2013. Therefore project specifics are not included here, but can be accessed in the prior document. This second application therefore focuses on how I wish to further develop the work with CALM, and also my academic networks with Goldsmiths, London. * I am applying to the Santander Bursary in order to progress a specific piece of collaborative work with Exeter University's Centre for Additive Layer Manufacture (CALM) in the College of Engineering, Mathematics and Physical Sciences. The first award of Santander Funding has already facilitated a number of meetings with researchers at CALM. These gatherings have enabled me to look at the development of "Untitled_Force"; how the 3D prints can be built with the help of the CALM research expertise, software and machinery. Working in collaboration with specialist engineers James Bradbury and Richard Davies, we have now modelled the first in the series of scan data - and are currently printing a fragment of the scan at 60,000 times the original sample size of 50x50µm (micrometres). I now wish to apply to the Santander Travel Bursary, in order to enhance and augment the project. This bursary will enable me to take my project through from the initial prints to a more substantial body of work - from the MPhil through to the PhD completion. The project will enable a deeper understanding of how contemporary digital technologies are changing perceptions of relative scale: considering these 3D prints in relation to spaces and locations rendered visible by networked technologies, such as satellite vistas. In addition, the Santander monies will enable me to travel to Goldsmiths University London - in order to further contextualise my investigations into the latest digital technologies used for industrial manufacturing. Here I will present the work at the seminar "Critical Ways of Seeing - Visualising Knowledge in a Digital Age". By attending the Masterclass I will be able to meet and network with PhD Researchers and Academics at this institution who are researching similar interests. The opportunity will also provide me with an excellent exhibition platform for the work.	
Justification for support (maximum 350 words) – address how this proposal will help you research project or personal development, the potential benefits and the value for money	
The 3D print of "Untitled_Force" will reveal a new way of modelling biological data, enabling a deeper understanding of how contemporary technologies are changing perceptions of our own 'digital' bodies. The detail presented in the CAD file, from the Atomic Force Microscope scan is incredibly complex, as the 3D model of "Untitled_Force" has over two million facets. At preliminary meetings with CALM we analysed the data, and found to manufacture the entire model would need a 200x200x35cm volume. This would take four builds, priced at £5,000 each (clearly outside of my budget). However, as a Practice-based PhD student, the practice-based element of the work is an integral part of the Methodology; it is only through making the 3D print that conclusions can be drawn. Therefore my intention now is to work with CALM to produce specific fragments of the scan at different scales. This will reveal the varying complexity of data at different ratios (from 20,000:1, 60,000:1 - upwards) and will highlight the facets in ever changing requisite detail. My revised budget covers the new production costs, materials (Polyamide 12 nylon powder) and digital programming to develop and print a further three models of Untitled_Force; as fragments produced at different scales. (My original budget from the first application still includes monies to cover all travel to CALM for meetings).	

This second proposal will also cover my travel costs to Goldsmiths University, London - to present the work at “Visualising Knowledge in a Digital Age". My application for train and overnight accommodation will enable me to attend both days of the Masterclass.

Whilst the original Santander Bursary has enabled me to develop links with academics at CALM and other areas of Exeter University – this PhD Masterclass at Goldsmiths will broaden my networks with academic research staff and peers in the field of Experimental Media Research; these include Sean Cubitt (Media & Comms); Graham Harwood (Cultural Studies) and Jennifer Gabrys (Design). Having presented work alongside Harwood and Gabrys at Transmediale Berlin recently - I believe that this is the perfect context for my burgeoning research practice.

Value for Money: as introductions with CALM researchers are established, time and resources from this application can be dedicated to building the tangible outcomes. This research will be disseminated widely - both in new academic contexts at Goldsmiths and in public art exhibitions.

Deliverables (maximum 350 words) – list the anticipated outcomes or outputs

There will be three outcomes:

1) The ‘3D Prints’ of “Untitled_Force”.

After development of the initial 3D print (currently in production with funding from the first Santander Bursary) - I now would like to build 3 more sections from the scan data - which will be fragments of an Atomic Force Microscope scan of my blood. Due to the complexity and scale of the digital technologies - these will be magnified in an ascending scale - the minimum size being 60,000 times the original sample material.

2) Developing Networks.

It is still my intention to develop my relationships with existing collaborators and establish new partnerships with Exeter University, especially in the fields of Bio-Medical Physics and Medical Imaging.

However, I also wish to develop these networks with peers and associates at Goldsmiths University London. The PhD masterclass will broaden my networks with academics, research staff and peers who are in a similar field of Experimental Media Research; including Sean Cubitt, author of seminal text "Digital Aesthetics" (Sage London: 1998); artist Graham Harwood (YoHa) and artist/academic Jennifer Gabrys. Face-to-face meetings and personal introductions to these academic researchers will be invaluable.

3) Public Exhibitions

As this research is located in the field of media arts, its main outcome will be available to the public at large, not just a specific research community, bringing an understanding of the impact of digital 3D print to a wider audience.

When the initial 3D print prototype was exhibited to the public at the Exeter Phoenix Art Gallery (November 2012-January 2013) it received critical attention from the curator and many responses from members of the public. These included tweets from a science journalist working in the field of climate change (Andy Extance, simpleclimate.wordpress.com).

The opportunity to participate in “Critical Ways of Seeing - Visualising Knowledge in a Digital Age” will provide me with an excellent exhibition platform for the work. The discussion generated by this event will deepen and embolden my PhD research and develop networks of academic researchers at Goldsmiths London, Exeter University and BU.

It is also my intention to present the new 3D prints in a public exhibition of "Untitled_Force" at Bournemouth University and I will also present the works-in-progress at a public exhibition at Spike Island, Bristol in May 2013.

Precise breakdown of costs – include travel, accommodation, subsistence, registration costs, etc

Item or activity	Details	Cost
Production Costs	ALM - Prints	
Exeter University - Centre for Additive Layer Manufacture Materials for test prints and final ALM/3D build	Development and production: machine costs (preferential subsidised rate) including: Nylon 12 (Polyamide) Powder Software Programming Machine costs 3 x Prints @ £600 each	£1800.00
Travel to Goldsmiths University	Return train ticket to London	£ 57.00
Participation in Critical Ways of Seeing - Visualising Knowledge in a Digital Age	TFL Day tickets £8.80 each Overnight accommodation (£65 night x 2)	£ 17.60 £130.00
	Total	£2004.60

Section 4 – Supervisory recommendation

Do you support this proposal Supervisory Assessment	Yes ☒	No ☐

Assess the importance of this proposal to the individual’s research project or personal development (maximum 350 words)

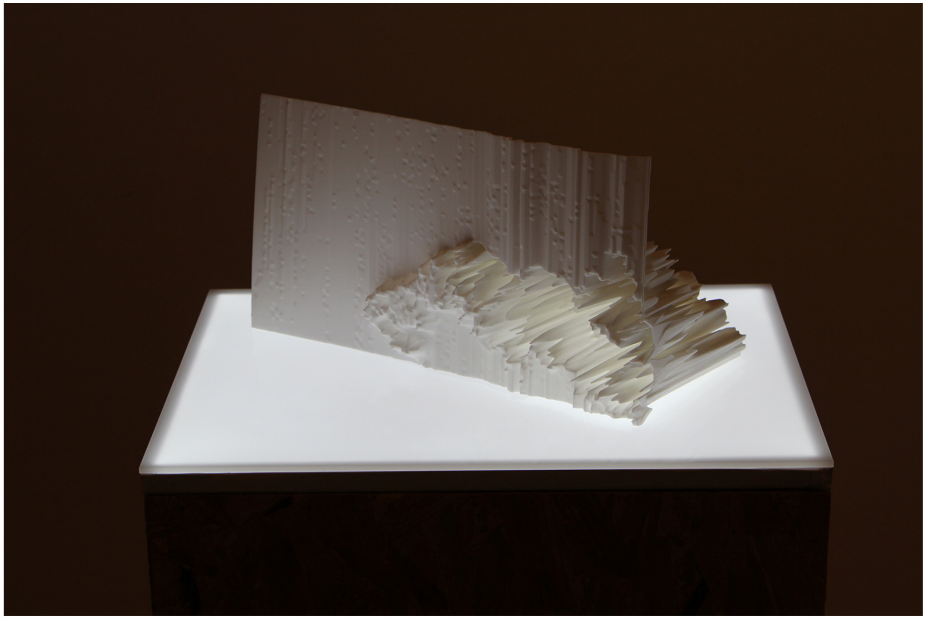
This Santander grant will enable Katy to build on successful relationships that have developed through the support of her earlier successful funding application. A large part of the funding that Katy has applied for will facilitate the creation of a tangible research outcome from her collaboration with CALM Exeter University. The creation of the work is essential to her PhD progress, as in a practice-based aproach the physical work itself is the research outcome. Without the funding from Santander Katy would struggle to find the funding to take this project to its logical conclusion.

The other portion of the money requested will enable Katy to disseminate her research through exhibtion at the attendance of a masterclass at Goldsmiths Univeristy London. Oportunities of this kind add essential validity to the research practice; enabling the practice-based outcomes to be critically appraised by a body of research active peers. Such an opportunity will benefit Katy greatly in the progression of her PhD.

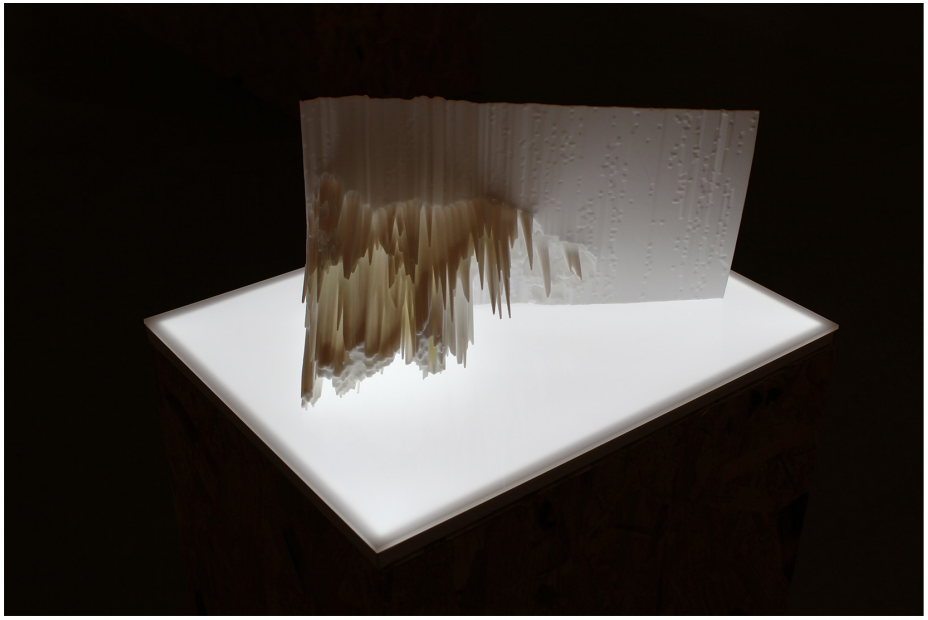
Section 5 – Signatures (applications are deemed incomplete if signatures are missing). (Add additional rows if required)			
Applicant	Katy Connor	Date	08/03/13
Supervisor	Dr Tom Davis	Date	08/03/13

It is the Graduate School's policy to publish a summary of awarded projects on the BU Research Blog. Please tick this box if you do not consent to this	☐

Katy Connor
BU Santander PGR Grant Application
January 2013



Front view



Rear view

Katy Connor
“Untitled_Force” (2012)
3D Print in Nylon12

“Untitled_Force” is a series of works that visualises an Atomic Force Microscope scan (AFM) of my blood.
The 3D print presented here is a tiny fragment of the original scan data file, magnified approximately 20,000 times.
The work was presented as part of the NeoReplicants exhibition at Exeter Phoenix Art Gallery, November 2012 - January 2013.

Appendix 9:

Email correspondence between Katy Connor and CALM:
Centre for Additive Layer Manufacture, Exeter University

July 2012 - October 2014 (46 pages)

Gmail by Google [redacted]

RE: C230 P001 CALM

2 messages

Bradbury, James [redacted] Fri, Jul 13, 2012 at 4:09 PM
To: [redacted]

Good afternoon Katy,

I have managed to convert your file and have been able to create a thickness.
However as it stands the detail is to fine.
The minimum thickness of a "spike" needs to be 1mm.
This means either increasing the physical size of it (which I can do) or increasing the thickness of the "spikes" which you will have to do.

I have attached an image showing you what I can see and work with. Is this what you were expecting??

Please let me know if there is any more information you require.

Best regards,

James.

-----Original Message-----
From: [redacted]
Sent: 12 July 2012 15:40
To: Bradbury, James
Subject: Re: C230 P001 CALM

Dear James,
How are you - I hope you're well? I'm writing with regard to the CALM project - as I have two designs that I'm currently working on - and I'd like to run them past you.

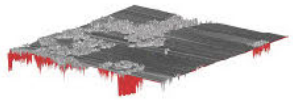
I'm designing one in Google Sketch Up (which is based on a Skype Glitch) and the second is from an Atomic Microscope Scan image. I've created the AFM scan as an .obj file in MeshLab - but I'm not sure how to make it into a solid form - as its currently a 2D mesh. I'm imagining it may be quite easy to create a duplicate, and simply fill in the space between the two? But as I'm not sure how to do this, I thought I'd send it so you can have a look!

I'm anticipating that this could go along the bottom of the ALM volume as a 50-70mm slice - as the Skype Glitch will be more like a cuboid form.
I've attached a jpeg of the scan - so you can get a sense of what it looks like as an image file - and have invited you to a DropBox file which has the meshlab document inside it (as its 189MB).

Please let me know if/when you have any thoughts about the first - and I'll send the other design, once I've managed to work with Google SketchUp!
Thanks James,
Speak to you soon

Best wishes
Katy

[redacted]



untitled force 2_stl.jpg
149K

Bradbury, James [redacted] Wed, Jul 18, 2012 at 3:31 PM
To: [redacted]

Good afternoon Katy,

Please find attached some images of your piece.
I have managed to give the scan a 2mm thickness and keeping 95% of the detail on the spikes.
I have also enlarged the piece to 400mm square and separated it into 4 parts. This now can be built in 4 sections and jointed back together using plastic glue (which can be brought from B+Q).

This should fit within your allocated build area.

Please let me know your thoughts.

Best regards,

James.

-----Original Message-----
From: [redacted]
Sent: 17 July 2012 13:53
To: Bradbury, James
Subject: RE: C230 P001 CALM

Dear James,

Hi, thank you for your email - I have a few more questions;

Firstly, regarding the AFM Scan - if you were to increase the physical size of each 'spike' to be 1mm, how big would the final piece be? ie Would it still fit inside the volume I've been allocated?
With this piece it is important that I keep to the integrity of this Scan data, so ideally I do not want to increase the thickness of the "spikes" myself.
However if this means that the final volume is too big for the allocation, I'd be willing to consider printing this as a separate commission - depending on price/materials etc. as it relates to a continuous body of work I'm developing.

http://katyconnor.com/NEW_Untitled_Force.html

Secondly, re the image that you sent: I'm assuming you can 'print' the whole image that we see here - including the red "underside"? Again it is important to the integrity of the piece, that the whole data be used.

I am still working with the Google SketchUp, and anticipate that this could be a much smaller piece than I'd originally planned - so it could possibly fit alongside a larger print.

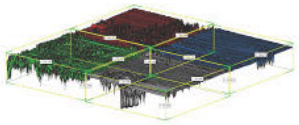
I look forward to hearing from you anyway James, Best wishes

Katy

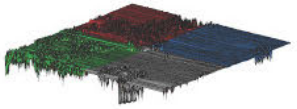
[redacted]

[Quoted text hidden]

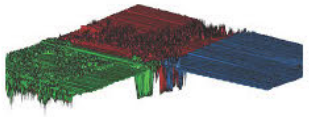
3 attachments



180712_image1.jpg
239K



180712_image2.jpg
209K



180712_image3.jpg
259K

Gmail by Google [redacted]

RE: 3D Print project with Exeter Phoenix

12 messages

Bradbury, James [redacted] Wed, Sep 19, 2012 at 1:31 PM

[redacted]
Cc: Calm Centre Mail <[redacted]

Good afternoon Katy,

Unfortunately Matt has jumped the gun and we are still working hard to complete all of the artists work.
I can confirm your piece is in the workflow and I will try and get a date for you.

Best regards,

James.

-----Original Message-----
From: [redacted]
Sent: 19 September 2012 13:14
To: Bradbury, James
Cc: Calm Centre Mail
Subject: 3D Print project with Exeter Phoenix

Dear James,
Following on from Matt Burrows' email yesterday, I just wanted to check that everything is fine with my 3D print, as I haven't yet received it?
I understand that the deadline is 1st October, but Matt did mention that they'd all been completed now.

I look forward to hearing from you,
Best wishes
Katy

[redacted]

Quoting "Bradbury, James" [redacted]

> All,
>
> I hope everyone's project is going well and the work I have seen so
> far from some of you has been very impressive.
>
> I thought I would just mention that I will be off on holiday the
> week (6th - 10th Aug) leading up to the 10th August 2012.
> If you are needing any support or advice from myself, please could
> you ask me prior to then.
>
> If there are any further questions etc which need answering whilst I
> am away, Richard, Ed and Adam will be here and contactable at
[redacted]
>

> Best regards,
>
> James.
> ----------
> Mr James Bradbury, Research and Application Engineer, Centre for
> Additive Layer Manufacturing (CALM) - Business
> Technology Centre, University of Exeter, Harrison Building, North
> Park Road, EXETER, DEVON. EX4 4QF
> ----------
> Tel : [redacted]
> Email [redacted]
> Email [redacted]
> Web: [redacted]
> ----------
> The Centre for Additive Layer Manufacturing (CALM) is funded by the
> SouthWest Regional Development Agency and the European Regional
> development fund and partnered with EADS Ltd.
> [cid:image001.jpg@01CC003E.D4BA8E30]
> [cid:image002.jpg@01CC003E.D4BA8E30]
> [cid:image003.png@01CC003E.D4BA8E30]
>
>

Bradbury, James [redacted] Thu, Sep 27, 2012 at 3:23 PM

[redacted]
Cc: Calm Centre Mail [redacted]

Good afternoon Katy,

I hope you are well.
We are ploughing through all the work and what we have seen is really fascinating.
I can confirm your parts are due to be build on the 2nd October, with a scheduled delivery date of Monday 8th October 2012. Unfortunately we will be one week late, as in hindsight we should of given ourselves 8 - 10 weeks instead of 6 weeks.

I will send the paperwork in the post to you in advance, so please could you sign and return.
This will help speed up the process.

Please let me know if this is ok.

Best regards,

James.

-----Original Message-----
From: [redacted]
Sent: 27 September 2012 14:57
To: Bradbury, James
Cc: Calm Centre Mail; D'Souza, Adam
Subject: RE: 3D Print project with Exeter Phoenix

Dear James,

Just a quick email to check the progress with the 3D print - as I haven't had a completion date yet.

I'm giving a presentation and artists talk at Bournemouth in early October and wish to include the print as part of the presentation.
Could you please let me know when to expect to receive the work?

Thank you,
Best wishes
Katy
[Quoted text hidden]

Bradbury, James [redacted] Thu, Sep 27, 2012 at 3:41 PM
To: [redacted]

Hi Katy,

Thanks for the new address.
I've just put your form in the post to your new address.

Once your parts are built, I will send a photo and update via email.

Best regards,

James.

-----Original Message-----
From: [redacted]
Sent: 27 September 2012 15:32
To: Bradbury, James
Subject: RE: 3D Print project with Exeter Phoenix

Hi James,
Yes this will be fine thanks, although any later will be a problem.

I don't think you have my new home address - which is
8 Windmill Hill Bristol BS3 4LU.

If you can send the paperwork to my home address and the print to the studio, that would be best.
Otherwise please send both to my home address.
Hope this doesn't present any problems,
[Quoted text hidden]

Bradbury, James [redacted] Fri, Oct 5, 2012 at 3:14 PM
To: [redacted]

Good afternoon Katy,

I have some good and bad news for you.
We have tried to make your part for you as requested, however as you can see by the photos, the detail on the spikes has been lost and the part warped and bent due to the thickness and shape.
The whole team has been trying all week to come up with a solution to these problems, but as of yet we have not.

This will obviously mean we will not be able to supply you with your parts for your talk next week, as

originally promised. I am truly sorry for this. We will of course continue to try and work this out to delivery your art to you as quickly as possible, but as it stands you are the only artist who has managed to beat us when it comes to building a part.

I will contact you next week to update you on the situation.

Best regards,

James.

-----Original Message-----
F[redacted]
Sent: 27 September 2012 15:50
To: Bradbury, James
Subject: RE: 3D Print project with Exeter Phoenix

Dear James
thank you! Will return the form asap.
I'll look forward to seeing the print too, hope it's not been too stressful for you all,

Thanks again,
[Quoted text hidden]

---

2 attachments

DSC08544.JPG
2336K

DSC08546.JPG
1643K

[redacted] Mon, Oct 8, 2012 at 11:53 AM
To: [redacted]

--[redacted]
Date: Mon, 08 Oct 2012 11:45:37 +0100
[redacted]

[redacted]
Subject: Fwd: RE: 3D Print project with Exeter Phoenix
To [redacted]

----- [redacted]
Date: Mon, 08 Oct 2012 11:43:14 +0100
[redacted]
Subject: RE: 3D Print project with Exeter Phoenix
To: "Bradbury, James" <[redacted]

Dear James,
Thank you for your email and for keeping me up to date with the progress of the 3D print. I appreciate that you're working hard to resolve the difficulties with the printing process and the scan data. Thank you also for sending through the photographs, as it gives a sense of what the print looks like at this stage - and I think it looks really interesting.

This is just a thought, but do you think that making the print in a stronger material than the synthetic plastic may give the piece more strength and prevent the warping and loss of detail?

If you think it would be helpful, I'm in Bristol most days this week, so could easily come down to discuss the issues in person. Otherwise I'll wait to hear from you. thanks for keeping in touch,
Best wishes

Katy

Katy Connor
Artist | PhD candidate in Experimental Media
[redacted]

Spike Island Studios, Bristol
[redacted]

Sent from my iPhone
[Quoted text hidden]
----- End forwarded message -----

----- End forwarded message -----

Katy Connor [redacted] Mon, Oct 8, 2012 at 12:00 PM
To: "[redacted]"

> ----- Forwarded mes[redacted]
> Date: Mon, 08 Oct 2012 11:43:14 +0100

> From: [redacted]
> Reply-To [redacted]
> Subject: RE: 3D Print project with Exeter Phoenix
> To: "Bradbury, James" [redacted]
>
>
> Dear James,
> Thank you for your email and for keeping me up to date with the
> progress of the 3D print. I appreciate that you're working hard to
> resolve the difficulties with the printing process and the scan data.
> Thank you also for sending through the photographs, as it gives a
> sense of what the print looks like at this stage - and I think it
> looks really interesting.
>
> This is just a thought, but do you think that making the print in a
> stronger material than the synthetic plastic may give the piece more
> strength and prevent the warping and loss of detail?
>
> If you think it would be helpful, I'm in Bristol most days this week,
> so could easily come down to discuss the issues in person.
> Otherwise I'll wait to hear from you. thanks for keeping in touch,
> Best wishes
>
> Katy
>
> Katy Connor
[Quoted text hidden]

Katy Connor [redacted] Wed, Oct 10, 2012 at 3:40 PM
To: [redacted]

Dear James,
I hope you're having a good afternoon.
Further to my previous email sent on Monday, I wondered if you have any ideas regarding possible dates for when the print might be complete?

Yesterdays email from Matt stated that I will need to drop the print to the gallery on 5/6th November, so if possible I'd like to request that the print arrives by 29th October - as this gives me a little time to consider the context and equipment for display.

I can also collect the print if this makes it easier/quicker to transport. I look forward to hearing from you in due course James,

Thanks again for your help with this.
Best wishes
Katy
[Quoted text hidden]

Bradbury, James [redacted] Wed, Oct 10, 2012 at 4:14 PM
To: Katy Connor [redacted]

Good afternoon Katy,

A couple of ideas we may have is trying to focus on one small area of the scan and enlarging this area to print. What do you think??

Secondly we are looking at the other ALM processes as we may have a better chance manufacturing your scan in other way.

I have made Matt aware of the problems we are facing ad will endeavour to complete your work before the 29th October 12.

I will keep you posted.

Best regards,

James.

-----Original Message-----
[Quoted text hidden]

---

katy connor [redacted] Wed, Oct 10, 2012 at 5:08 PM
To: "Bradbury, James" [redacted]

Hi James,

Thank you for your email, I appreciate that this print must be a bit of a challenge for you all..
Before I can make any further decisions regarding enlarging the scan/print, or any other ALM processes however, I would really like to come and see the prints in person, and to discuss the options with you.
Although the photographs are helpful, I can't clearly see the level of detail on the spikes from the close-up image.
From an artist's perspective, this disturbance may be the really interesting feature within the whole process!

Can I suggest that we meet to have a quick chat about this (no longer than an hour) and I can see the prints in close-up detail? I'm free to pop down either tomorrow (Thursday) or anytime Friday.
Next week I'll be available on Tuesday 16th.

Could I ask that you also keep hold of these 'mistakes' with the print, as they are really very interesting from an artists POV.

I look forward to hearing from you,
With best wishes

Katy

Katy Connor
Artist
[redacted]

Spike Island Studios, Bristol
[redacted]
[Quoted text hidden]

Bradbury, James <[redacted] Thu, Oct 11, 2012 at 10:34 AM
To: katy connor <[redacted]

Good morning Katy,

Please could we arrange for you to visit next Tuesday (16/10).

I am flexible on time so please let me know what time is suitable for you.

I have kept the scarp parts, so you are more than welcome to take them home with you.

Please let me know and I will arrange things my side.

Best regards,

James.

From: katy connor [redacted]
Sent: 10 October 2012 17:09
To: Bradbury, James
Subject: Re: 3D Print project with Exeter Phoenix

[Quoted text hidden]

---

katy connor [redacted] Thu, Oct 11, 2012 at 11:17 AM
To: "Bradbury, James" <[redacted]

Hi James, Good morning,
Thank you for arranging this visit - I can be with you at 11am on Tuesday 16th.
I look forward to seeing you then,
Best wishes

Katy
[Quoted text hidden]

Bradbury, James <[redacted] Thu, Oct 11, 2012 at 11:27 AM
To: katy connor [redacted]

Hi Katy,

Sounds good to me.

I have booked a meeting room and I will reserve you a car parking space next to the CALM reception.

When you arrive, please come to the CALM reception and I will meet you there.

Best regards,

James.

From: katy connor [mailto:[redacted]
Sent: 11 October 2012 11:18

[Quoted text hidden]

[Quoted text hidden]

Gmail [redacted]

C230 P001: Update (CALM - University of Exeter)

11 messages

Bradbury, James <[redacted] Tue, Oct 16, 2012 at 4:31 PM
To: katy conno[redacted]

Good afternoon Katy,

Once again thank you so much for making the effort to visit CALM to discuss your work and the current project.

It was so useful in fact I believe I may very well have a solution (Maybe)!!

I have been successful in creating section 1 (your first choice) data for an attempted build.

Please find attached an image of the section with information.

For your record:

- The wall thickness of the data ranges from 1mm up to 3mm
- Unfortunately some fine detail (below 1mm) has been lost, however if successful I believe you will be happy with the outcome!
- The section is approximately 270mm x 355mm total but is split in two parts, the will be joined together
- The largest spikes go up to 125mm long
- This section will be made a 455 times larger than the original size

The data has been refined enough so I have been able to process and slice ready for manufacture.

Please can you let me know if you are happy with this?

If so I will schedule this into Fridays build with a view of reviewing the part on Tuesday (23/10).

Best regards,

James.

[redacted], Centre for Additive Layer Manufacturing (CALM) - Business

[redacted]

4QF

Tel : [redacted]

Email [redacted]

Email : [redacted]

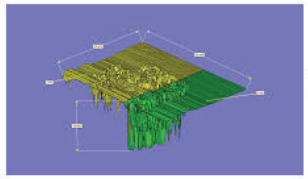
Web: [redacted]

The Centre for Additive Layer Manufacturing (CALM) is funded by the SouthWest Regional Development Agency and the European Regional development fund and partnered with EADS Ltd.

European Regional Development Fund
Investing in your Future

South West
SOUTH WEST ERDF COMPETITIVENESS AND EMPLOYMENT PROGRAMME

South West RDA



161012_section1.jpg
140K

katy connor [redacted] Wed, Oct 17, 2012 at 12:43 PM
To: "Bradbury, James" [redacted]

Hi James - good afternoon -
Thank you for your time yesterday - it was really helpful to meet and find out about the project first hand!
And thank you for sending the image over so quickly - I've given it a great deal of thought in the light of the two test prints you gave me yesterday - and everything we discussed!
I am really happy with the scale and I think it could look great.

I do have one request - which is an artistic decision. Would it be possible to make the print as a square object?
As it currently stands, the length is 355.452 x width 272.677.
Would it be possible to make the two sides the same length (355.452 for example)?

The reason for this is that I have to think about the print, both in relation to its source data (AFM scan)

and the series as a whole. The work is also about notions of scale and cartography (therefore the square grid of cartographic systems used to 'map' space and visual perspective is a key aspect of the work.)

To make the print square would keep this particular 3D print work consistent with the other works in this series.

Would this be possible?

Thank you for your time James,
I look forward to hearing from you soon.
Best wishes

Katy

Katy Connor
Artist I PhD candidate in Experimental Media
[redacted]

Spike Island Studios, Bristol
[redacted]

[Quoted text hidden]

Katy Connor <[redacted] Fri, Oct 19, 2012 at 12:04 PM
To: "Bradbury, James" [redacted]

Dear James,
good afternoon, I hope you are well.

I wanted to check to see if you received my email regarding the possibility of changing the print dimensions?
I hope that everything is still fine to progress with the manufacture today as planned. However, if you did have any issues with my request please could you contact me to discuss?

Thank you James,
Best wishes

Katy

Sent from my iPhone

Begin forwarded message:

> **From:** katy connor <[redacted]
> **Date:** 17 October 2012 12:43:36 GMT+01:00
> **To:** "Bradbury, James" <[redacted]
>
> **Subject: Re: C230 P001: Update (CALM - University of Exeter)**

> [Quoted text hidden]
> [Quoted text hidden]
> [Quoted text hidden]
> [Quoted text hidden]
> [Quoted text hidden]
>
> <image001.jpg> <image002.jpg> <image003.png>

Bradbury, James <[redacted] Fri, Oct 19, 2012 at 3:58 PM
To: Katy Connor [redacted]

Good afternoon Katy,

Sorry I did not get back to you earlier in the week.

However I have some excellent news (please see photos attached);

I have been successful in building the section of the scan.

I have to say it has come out really we, but as you can imagine it is extremely fragile.

Unfortunately I had already started building the parts before I have an opportunity to read your email.

However the part can be cut to be made square in you so wish.

I would ask because it is so fragile, if you would be happy to come down to collect it at your convenience.

Please let me know if this is possible and if so what time best suits you.

I hope you have a good weekend.

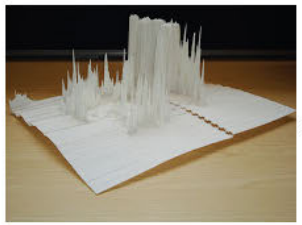
Best regards,

James.

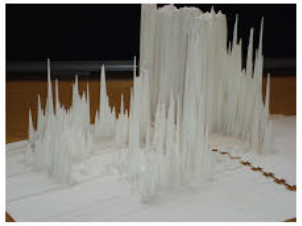
From: Katy Connor [mailto[redacted]
Sent: 19 October 2012 12:05
To: Bradbury, James
Subject: Fwd: C230 P001: Update (CALM - University of Exeter)

[Quoted text hidden]

2 attachments



DSC08599.JPG
2214K



DSC08600.JPG
1687K

katy connor <[redacted] Mon, Oct 22, 2012 at 9:19 AM
To: "Bradbury, James" <[redacted]

Hi James, good morning - I hope you had a nice weekend.
Thank you for your email. From your photographs the piece looks fantastic.

As it's very fragile, I would like to come and collect it by car.
I can be there around 10.30/11am on Wednesday morning (24th October).

Please let me know if this is all ok,
Best wishes

Katy
[Quoted text hidden]

Bradbury, James <[redacted] Mon, Oct 22, 2012 at 9:22 AM
To: katy connor <[redacted]

Good morning Katy,

I have a meeting at 11am to 12pm on Wednesday, so if you can come in before that that would be great.

If not, don't worry I will try and arrange for one of the other CALM team to be here to give you the part.

Please let me know if this is still ok and I will sort this out my end?

Best regards,

James.

From: katy connor [mailto:[redacted]
Sent: 22 October 2012 09:19
To: Bradbury, James

[Quoted text hidden]

[Quoted text hidden]

katy connor <[redacted] Mon, Oct 22, 2012 at 9:28 AM
To: "Bradbury, James" [redacted]

PS.
Re the glueing together of the two pieces.
Could I ask if I could take a little of the nylon powder when I collect the print on Wednesday? I can then mix this with the araldite which will give a smoother finish when fixing the two pieces together.

Thanks again James,
Best wishes

Katy
[Quoted text hidden]

katy connor <[redacted] Mon, Oct 22, 2012 at 9:29 AM
To: "Bradbury, James" [redacted]

Hi James
Yes - that's fine I'll be there between 10-10.30am.

Bests
Katy
[Quoted text hidden]

Bradbury, James <[redacted] Mon, Oct 22, 2012 at 9:34 AM
To: katy connor <[redacted]

Of course,

Please remind me when I see you.

Best regards,

James.

From: katy connor [redacted]
Sent: 22 October 2012 09:28
To: Bradbury, James

[Quoted text hidden]

[Quoted text hidden]

Katy Connor <[redacted] Wed, Oct 24, 2012 at 5:26 PM
To: "Bradbury, James" [redacted]

Dear James
Sorry I missed you today.
Just wanted to say thank you for the print.

See you on 15th November,
All the best
Katy
[Quoted text hidden]

Bradbury, James <[redacted] Thu, Oct 25, 2012 at 9:17 AM
To: Katy Connor [redacted]

Good morning Katy,

I'm glad to hear you are happy with the outcome.

I too look forward to seeing you next month.

Good luck.

James.

From: Katy Connor [mailto[redacted]
Sent: 24 October 2012 17:27

[Quoted text hidden]

[Quoted text hidden]

Gmail by Google [redacted]

3D Print project - the next stage

9 messages

[redacted] Wed, Jan 9, 2013 at 4:25 PM
To: [redacted]
Cc: [redacted]

Dear James and Sara,
Good afternoon - I hope you're both well and wish you both a Happy New Year 2013.

As the *NeoReplicants* show is drawing to a close, I wanted to get in touch as I'd be very interested to develop the 3D print project that we started through the Exeter Phoenix Bursary last year... (I've attached a photo of the final exhibition piece). I hope you enjoyed the experience too.

I'm looking at potential sources of funding from my University, in order to continue the work in the context of my PhD practice. The monies (up to £1000) could go towards covering some initial costs for development and printing - so I am just putting together an application for support.

Sara, I wondered if you could possibly email me some prices that you normally charge for consultation/development - (ie by the hour) so that I can add them into my application?
Some basic figures would be excellent to get the ball rolling. Don't worry - at this stage, any prices are simply needed for the funding application, so they can be approximate and not binding - We can reconfirm them at a later date, if/when the funding comes through.

I do hope you'd both be interested to continue to work together on this - and I look forward to hearing from you soon.
Sent with best wishes

Katy

Katy Connor
Artist | PhD candidate in Experimental Media
[redacted]

Spike Island Studios, Bristol
[redacted]

KC_Exhibition.jpg
471K

Calm Centre [redacted] Mon, Jan 14, 2013 at 10:44 AM
To: katy connor [redacted]
Cc: [redacted]

Good morning Katy.

I did indeed have an enjoyable Christmas and New Year. Thank you for asking.

And I hope you did too!!

To help with your application for support please find listed below rough breakdowns of cost for your information;

Cost to manufacture and post finish the piece we did for the NeoReplicants exhibition for you was approximately £600.00 excluding VAT.

The rate we charge for our time is £600 per day or £300 per ½ day.

Depending upon the scope of the work, we can discuss how this looks closer to the time.

I hope this brief outline is enough to get you started with this application.

Please feel free to contact me if you require any further information.

Best regards,

James.

From: katy connor [redacted]
Sent: 09 January 2013 16:25
To: Bradbury, James; Flint, Sara
Cc: Calm Centre Mail
Subject: 3D Print project - the next stage

[Quoted text hidden]

katy connor [redacted] Mon, Jan 14, 2013 at 11:35 AM
To: Calm Centre [redacted]

Dear James,

Good Morning,
Thank you for this information - that's really helpful - and I'll submit the proposal for my funding application today.
We should hear about the decision within the next couple of weeks - and I'll keep my fingers crossed.

I look forward to speaking to you again soon James,
Have a good week.

Best wishes,
Katy
[Quoted text hidden]

Katy Connor [redacted] Sat, Feb 9, 2013 at 7:57 PM
To: Calm Centre [redacted]
Cc: "Flint, Sara" [redacted]

Dear James and Sara,
I hope this email finds you both well.

I'm delighted to say that my funding bid was successful and I've received £1000 to continue to work on the 3D Print project.
The monies are allocated for costs in manufacturing the print, plus any travel / subsistence incurred for meetings at CALM, Exeter University.

I would therefore like to propose an initial meeting with you, so that we can discuss the project and the anticipated outcomes and costs to produce the work. However, if it looks as if the project will need additional support, I will also investigate further funding streams.

I'm really looking forward to working with CALM again on this project, and look forward to hearing from you soon.

Sent with best wishes

Katy

Katy Connor
Artist | PhD candidate in Experimental Media
[redacted]

Spike Island Studios, Bristol
[redacted]

On Mon, Jan 14, 2013 at 10:44 AM, Calm Centre Mail [redacted]
[Quoted text hidden]

Calm Centre Mail [redacted] Wed, Feb 13, 2013 at 3:45 PM
To: [redacted]
Cc: [redacted]

Good afternoon Katy,

Congratulations with your award.

I am away next week, but should be available after that for a meeting.

Please could you let me know what dates you are available and I will check my calendar and get back to you.

Best regards,

James.

From: Katy Connor [mailto[redacted]
Sent: 09 February 2013 19:57
To: Calm Centre Mail
Cc: Flint, Sara
Subject: Re: 3D Print project - the next stage

[Quoted text hidden]

Katy Connor [redacted] Thu, Feb 14, 2013 at 11:15 AM
To: Calm Centre Mail [redacted]
Cc: "Flint, Sara" [redacted]

Hi James
Good morning, and thank you for your email.

The dates that I'm available to meet that week, are Monday 25th and Tuesday 26th February - at any point during the day.
For your information, I've been advised that I can apply for a further £2000 to develop this project further - but the deadline for this application is Friday 8th March. However, we can discuss this and further project details when we meet.

I look forward to hearing from you soon,
Best wishes

Katy

Katy Connor
Artist | PhD candidate in Experimental Media
[redacted]

Spike Island Studios, Bristol
[redacted]

[Quoted text hidden]

Bradbury, James [redacted] Thu, Feb 14, 2013 at 11:30 AM
To: Katy Connor <[redacted]
Cc: "Flint, Sara" [redacted]

Good morning Katy,

Tuesday 26th February is best for us.

Could I suggest 10:30am at the University?

Please let me know if this is ok and I will go ahead with getting things in place?

Best regards,

James.

From: Katy Connor [redacted]
Sent: 14 February 2013 11:16
To: Calm Centre Mail
Cc: Flint, Sara; Bradbury, James
Subject: Re: 3D Print project - the next stage

Hi James
Good morning, and thank you for your email.

The dates that I'm available to meet that week, are Monday 25th and Tuesday 26th February - at any point during the day.
For your information, I've been advised that I can apply for a further £2000 to develop this project further - but the deadline for this application is Friday 8th March. However, we can discuss this and further project details when we meet.

I look forward to hearing from you soon,
Best wishes

Katy

Katy Connor

Artist | PhD candidate in Experimental Media
[redacted]

Spike Island Studios, Bristol
[redacted]

[Quoted text hidden]

Katy Connor [redacted] Thu, Feb 14, 2013 at 11:50 AM
To: "Bradbury, James" [redacted]
Cc: "Flint, Sara" [redacted]

Good morning James

Yes, this is all fine - Tuesday 26th February, at 10.30am.
Look forward to seeing you then - [and I'll try not to get lost this time]

Hope you have a nice week away James,
Best wishes

Katy
[Quoted text hidden]

Bradbury, James <[redacted] Thu, Feb 14, 2013 at 12:00 PM
To: Katy Connor [redacted]
Cc: "Flint, Sara" [redacted]

Good afternoon Katy,

I can confirm I have booked a meeting room for 10:30am on Tuesday 26th February 2013 for your visit.

I look forward to seeing you then to discuss your project and taking it further.

Best regards,

James.

From: Katy Connor [redacted]

Gmail [redacted]

C230 P002: CALM (University of Exeter)

31 messages

Bradbury, [redacted] Tue, Feb 26, 2013 at 4:06 PM
To: Katy Connor [redacted]
Cc: "Davies, Richard" [redacted]

Hi Katy,

Many thanks for coming in to visit us today.

I hope you found it useful.

As mentioned earlier, I have calculated the amount of sliced sections of the full scaled piece required to be built on the smallest and the biggest sized Laser Sintering Machines.

1) The largest system would be about 16 sections fitting into approximately 3-4 builds (A build equalling £5000 each)

2) The smallest system would be about 64 sections fitting into 25-30 builds (A build equalling £400 each)

I hope this answers your question regarding making the piece full size.

I will wait for you to make a decision on which option you would like to take forward and then jump straight on it once you have confirmed which one.

In the mean time please feel free to contact either myself or Richard if you have any further questions.

Best regards,

James.

Mr James Bradbury, Research and Application Engineer, Centre for Additive Layer Manufacturing (CALM) - Business

Technology Centre, University of Exeter, Harrison Building, North Park Road, EXETER, DEVON. EX4 4QF

Tel : [redacted]

Email [redacted]

Email : [redacted]

[redacted]

The Centre for Additive Layer Manufacturing (CALM) is funded by the SouthWest Regional Development Agency and the European Regional development fund and partnered with EADS Ltd.

European Regional Development Fund
Investing in your Future

South West
SOUTH WEST ERDF COMPETITIVENESS AND EMPLOYMENT PROGRAMME

South West RDA

full_scale.jpg
178K

Katy Connor <[redacted] Tue, Mar 5, 2013 at 10:49 AM
To: "Bradbury, James [redacted]
Cc: "Davies, Richard" [redacted]

Hi James - Good morning
Thank you for your email and the quotes for the building the full piece. Sorry it's taken me a while to reply.

For the next stage, I'd like to work with the magnification aspect of the section we previously printed.
I think it will be interesting to see how this piece can be scaled up further - and will be a good progression with the work if the next tranche of funding doesn't come through.

It would be good to identify a specific section for this - I'm thinking the area you hi-lighted as being 'shrink wrapped' ie the clump of spikes?
I've attached a photo here of the 3D print.

Richard - if you could send any links to MeshLab tutorials - I'd really appreciate it, so that I can look at this section of the data in closer detail?

Look forward to hearing from you again soon,

Thanks and best wishes

Katy
[Quoted text hidden]

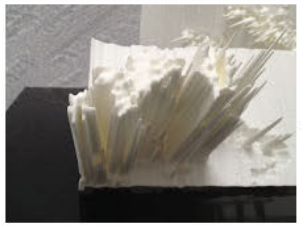


photo.JPG
457K

Davies, [redacted] Tue, Mar 5, 2013 at 11:31 AM
To: Katy
Cc: [redacted]

Hi Katy,

With regards to Meshlab they have a Youtube channel with a lot of tuition videos.

http://www.youtube.com/user/MrPMeshLabTutorials?feature=watch

Enjoy the musical intros J

I think the most useful tools for you initially will be the selection tools and delete option

I have attached a few images that highlight what you a going to need to do to trim down the data so you can focus on just one area as we discussed.

The process is pretty simple:- select area with rectangle tool – invert selection- delete the invert selected area leaving only the smaller area behind.

If you need anymore Meshlab help then I'm happy to talk through anything on the phone as well.

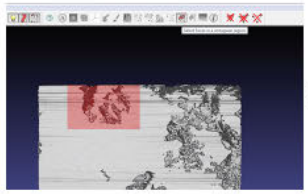
Kind Regards,

Richard

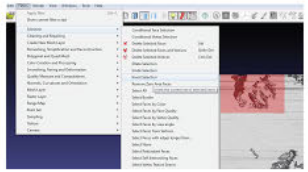
From: Katy Connor [redacted]
Sent: 05 March 2013 10:50
To: Bradbury, James
Cc: Davies, Richard
Subject: Re: C230 P002: CALM (University of Exeter)

[Quoted text hidden]

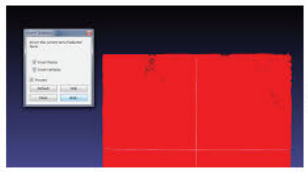
4 attachments



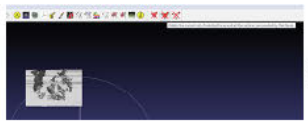
mesh-1.png
145K



mesh-2.png
105K



Mesh-3.png
67K



Mesh-4.png
54K

Bradbury, [redacted] Mon, Mar 11, 2013 at 12:23 PM
[redacted]

Good afternoon Katy,

I hope you had a good weekend.

As soon as you confirm the exact location (Spike/group) you would like us to build, I will be able to jump straight on it and raise all relevant paperwork etc.

Best regards,

James.

From: Davies, Richard
Sent: 05 March 2013 11:32
To: Katy Connor
Cc: Bradbury, James
Subject: RE: C230 P002: CALM (University of Exeter)

[Quoted text hidden]

Katy Conno [redacted] Mon, Mar 11, 2013 at 10:16 PM
To: "Bradbur [redacted]
Cc: "Davies, [redacted]

Hi James,
Thank you for your email - I had a very nice weekend, thank you :)

Thank you for the links/tutorials Richard- (yes, with v. funny music!) I've been having a look at the selected "shrink-wrap" area of the scan using Meshlab...
From our conversation, I had expected to see more specific spikes as I scaled up the selected area - but I can't seem to see any difference between the Meshlab model and the printed model (in the photos attached) - So a bit stuck on what to do next.

Would it be possible that you could send any screenshots that you have of this section of the model at a larger scale?

I'm in Bournemouth all day tomorrow (Tues/Wednesday) -weather permitting- but I will be available on the phone Tues morning, after 10.30am.
Have also applied for the second tranche of money - so should find out the outcome in next 4 weeks.

I'm aware this is taking a little longer than planned, but hopefully we can resolve it all soon,
Look forward to hearing from you
With best wishes

Katy
[Quoted text hidden]

2 attachments

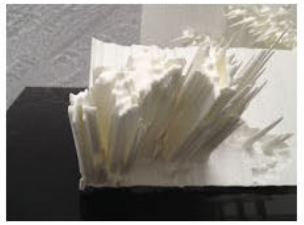
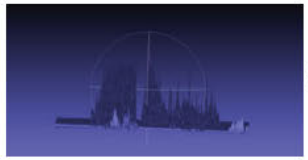


photo.JPG
457K



section.tiff
119K

Katy Connor [redacted] Tue, Mar 19, 2013 at 12:15 PM
To: [redacted]
Cc: [redacted]

Dear James, Richard and Sara

Further to my previous emails, I'm delighted to say that I've been awarded the second tranche of funding to work with CALM.
This means that we have a further £1800 - on top of the original £700 quote - to contribute to the project.
As before, the funding is through Santander/BU Graduate School and all monies must be spent by 31st July 2013.

I'm hoping that this will enable us to produce a further 3 x 3D models of the data (3 models @£600 each, including VAT) - on top of the £700 for the first print/programming already discussed. However, we can clarify this as the project progresses.
But I'm sure you'll agree that this offers us the opportunity to develop the work in new, creative and unexpected ways.

Thanks again for your support for the project - and I look forward to hearing from you,
Sent with best wishes

Katy

Katy Connor
artist | researcher
[redacted]

PhD Candidate - Experimental Media Art
EMERGE Bournemouth University Media School http://www.bournemouth.ac.uk/imcr/emerge/index.html
[Quoted text hidden]

[redacted] Wed, Mar 20, 2013 at 10:21 AM

[redacted]

Good morning Katy,

Congratulations on successfully being awarded the second lot of funding.

It is up to you how you would like to approach the second phase of the work.

Perhaps a quick telephone conversation just to clarify the first piece of work and your ideas on the second piece of work may be a good idea.

If you agree, please let me know a selection of dates and times which are convenient for you.

Best regards,

James.

F[redacted]
Sent: 19 March 2013 12:15
To: Bradbury, James
Cc: Davies, Richard; Flint, Sara

[Quoted text hidden]

[Quoted text hidden]

[redacted] Thu, Mar 21, 2013 at 8:50 AM
To: "E[redacted]

Dear James,
Many thanks for your email - I'm currently attending a masterclass in London until Friday evening.
I agree that a quick telephone conversation would be useful however and will be in touch later today with suggested times/days next week.
Look forward to speaking to you soon,

Very best wishes to you
Katy
[Quoted text hidden]

[redacted] Tue, Mar 26, 2013 at 5:49 PM
[redacted]

Dear James,
apologies for the delay - I caught a nasty bug in London and have been unwell for the past few days.
Regarding the project/phone call -
I would be free to speak with you about the first print, either tomorrow (Wednesday 27th) or Thursday 28th - from 9.30am until 3.30pm.
If you are free at all during these two days, please email to let me know what time's best for you, and we can discuss over the phone.

If that's not suitable, I'll next be free to discuss the project the week beginning Monday 8th April.
I can also make a visit to CALM that week, if we think it's best.

Best wishes
Katy

--------- Forwarded message ---------
[redacted]
Date: Thu, Mar 21, 2013 at 8:50 AM
Subject: Re: C230 P002: CALM (University of Exeter)
[Quoted text hidden]

[redacted] Wed, Mar 27, 2013 at 2:07 PM
[redacted]

Good afternoon Katy,

I'm sorry to hear you caught something whilst you were in London.

I am available any time after 11:30am tomorrow morning so please feel free to phone me on 01392 725 897 to discuss your work.

If you would like I am more than happy to phone you anytime after 11:30am tomorrow if you lead me know a phone number and time.

Whatever is easiest for you.....

Best regards,

James.

[redacted]
Sent: 26 March 2013 17:50
To: Bradbury, James
Subject: Fwd: C230 P002: CALM (University of Exeter)

[Quoted text hidden]

[redacted] Wed, Mar 27, 2013 at 3:22 PM

Hi James
Good afternoon and thanks for your email
I will give you a call tomorrow morning, soon after 11.30am.

Look forward to speaking with you then,
All the best
Katy
[Quoted text hidden]

[redacted] Thu, Mar 28, 2013 at 11:56 AM

Hi James -
image of spikes attached ...

bests
Katy
[Quoted text hidden]

spikes.jpg
2415K

[redacted] Thu, Mar 28, 2013 at 4:11 PM

Hi Katy,

As promised, please find attached the image you sent earlier identifying the area you selected to magnify.

I have been able to produce that section and have managed to scale it up to approximately 400mm3.

For us to manufacture it this big, we would need to cut it up into 4 sections and nest them together to form the build.

Please could you take a look at the images and let me know what your thoughts are?

I hope you have a good Easter break and look forward to speaking to you on our returns to work.

Best regards,

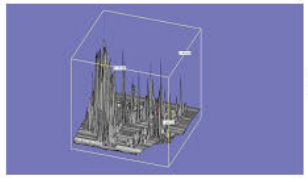
James.

[redacted]
Sent: 28 March 2013 11:57
To: Bradbury, James

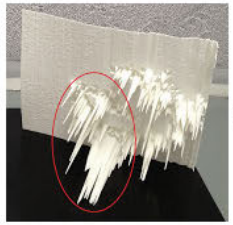
[Quoted text hidden]

[Quoted text hidden]

2 attachments



section1.jpg
112K



section1_identified.jpg
371K

[redacted] Mon, Apr 8, 2013 at 3:48 PM

[redacted]

Hi James and Richard - Good afternoon!
I hope you both had a great Easter break :)
Thank you for sending through these images James - I've now been able to give these some thought, and measured / compared the proposal in relation to the previous prints..

I do think this would be a good section to start with - in terms of seeing how the scan can build up at this scale - and how the 4 sections will nest together.
Its not very clear in the picture - but I'm assuming that the tallest spike is 448mm high?
Could you confirm this, and also where the dividing line for each section will be?

One more specific request (for aesthetic reasons) is that the base of each sample is simply either square or rectangular.
In the image here, there's a corner missing (which I'm assuming is another section of spikes).
However I would really like each section to be either square or rectangular in shape.

Look forward to hearing from you,
With best wishes

Katy
[Quoted text hidden]

[redacted] Tue, Apr 9, 2013 at 11:25 AM

Good morning Katy,

Easter Break was very nice, thank you.

I hope it was good for you too.

You are correct in that the tallest spike is approximately 450mm tall.

I have attached an image of the different sections (section1_sectionsdefined080413) for your review.

The reason why the section is not a square or rectangular is because I wanted to cut off the additional section of spikes on the top of this area.

I can redo the section leaving the additional spikes on, however this will reduce the over size by about a third.

I have attached (section1_boundrydefined) an image showing where the section was cut.

Please take a look and let me know your thoughts.....

Best regards,

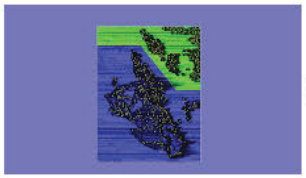
James.

From: [redacted]
Sent: 08 April 2013 15:48

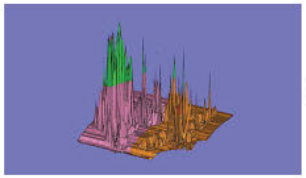
[Quoted text hidden]

[Quoted text hidden]

2 attachments



section1_boundrydefined.jpg
142K



section1_sectionsdefined080413.jpg
118K

[redacted] Tue, Apr 9, 2013 at 12:08 PM

Good morning James,
Thank you for your email - and for clarification of the shape -
I can confirm that the base of each sample needs to be either a square or a rectangle.

As I understand it - this would reduce the overall size/spikes.
I would really like the spikes for this - the first print - to remain at a minimum size of 400mm tall.
Therefore could you let me know if it would be possible to select a smaller area of this section to enlarge?

Looking forward to hearing from you,
Best wishes

Katy

[Quoted text hidden]

[redacted] Thu, Apr 11, 2013 at 5:07 PM

Hi James,
Good afternoon - I hope you're well. I just wanted to make sure everything was fine and that you didn't need any further info for the print?
If you would like to arrange another meeting, I could come down to visit next Thursday 18th April - if you think it would be good to discuss further options.
We could also look at the next areas for printing in more detail.

I look forward to hearing from you
best wishes,
Katy

[Quoted text hidden]

[redacted] Mon, Apr 15, 2013 at 11:48 AM

Good morning Katy,

Sorry I did not get back to you last week. Pretty frantic as you can imagine, first week back after a break.

However, as per our email conversation last week, I have reduced the section to focus in on a smaller section of the spikes, but ensuring the height is kept above 400mm as requested.

I have attached an image showing the location of the section, the overall section dimensions and an image showing where I have had to split the spikes into 2 sections to keep the length. I will reattach and assemble after it has been built.

Unfortunately we are running another day workshop with businesses this Thursday and so I am unavailable that day.

If you would like to have one further visit before we start the build, please let me know and I will check my calendar?

Please let me know if you have any further questions?

Best regards,

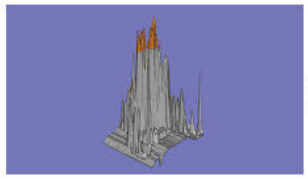
James.

[redacted]
Sent: 11 April 2013 17:08

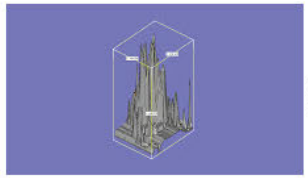
[Quoted text hidden]

[Quoted text hidden]

3 attachments



section1_rescaled_150413.jpg
76K



section1_rescaled_dims_150413.jpg
73K

spikes_section1_identified.jpg
430K

[redacted] Mon, Apr 15, 2013 at 1:28 PM

Dear James,
Thank you for sending these images. I'll have a look and get back to you asap.

I think it would be good to meet again before we develop any further prints - so we can discuss the options and clarify the next stage.
When we spoke on the phone, you also mentioned the possibility that I could also video/record the ALM build in the lab?
Could you let me know what dates you anticipate this could be?

Best wishes
Katy

[Quoted text hidden]

[redacted] Mon, Apr 15, 2013 at 1:47 PM

Good afternoon Katy,

As soon as you let me know if you are happy with the current proposed set up I will be able to raise the appropriate admin paperwork and allocate a time slot for your work.

As for videoing some of the build phase, I will be able to let you know a date after the above has been completed.

I hope this answers your question.

Best regards,

James.

From [redacted]
Sent: 15 April 2013 13:28

[Quoted text hidden]

[Quoted text hidden]

[redacted] Tue, Apr 23, 2013 at 10:41 AM

Good morning Katy,

I hope you had a pleasant weekend and the sun is out like it is here in Exeter for you!!!!

I thought I would just email you to see if you have had a chance to take a look at the information I sent through to you and if you have any questions or made any decisions yet?

Best regards,

James.

From: Bradbury, James
Sent: 15 April 2013 13:48
To: 'Katy Connor'
Cc: Davies, Richard
Subject: RE: C230 P002: CALM (University of Exeter)

Good afternoon Katy,

As soon as you let me know if you are happy with the current proposed set up I will be able to raise the appropriate admin paperwork and allocate a time slot for your work.

As for videoing some of the build phase, I will be able to let you know a date after the above has been completed.

I hope this answers your question.

Best regards,

James.

F[redacted]
Sent: 15 April 2013 13:28

[Quoted text hidden]

[Quoted text hidden]

[redacted] Tue, Apr 23, 2013 at 6:42 PM

Hi James,
Thank you for your email - the sun is shining here too! Yes, I've had a look at all the info you sent, so thank you for that.
I'd like to take another look at the model before I email you with some ideas/comments - but I'm currently in Bournemouth for a series of PhD supervision sessions - I'll be back in Bristol on Thursday - so I will be able to respond fully then.
Thanks again and speak to you soon,
Best wishes
Katy

[Quoted text hidden]

[redacted] Mon, Apr 29, 2013 at 9:53 AM

Hi James, Hi Richard
I hope you both had a great weekend,
Thank you for sending through the plans for the print James - I'm more than happy to go with this as the first model - so that we can start getting this first print underway. I just wanted to let you know that I'm currently preparing for my progression exam for the PhD - so my apologies for not responding to you sooner.

I understand that it takes time to get all the paperwork signed off - and my deadline for spending is 31st July - so can I suggest that we meet in order to discuss all elements of the remaining three prints?

Dates that I'd be free to meet at CALM are : Thurs 9th / Fri 10th May or 13th 14th 16th 17th May or 21st May.
I then have a research trip from 24th May - but will be free to meet again from 6th June.

The budget I have = £2500 for all four prints [£700 + £1800 (3 x 600)] - including VAT. With a further £100 contingency spend.

If you could let me know your thoughts and possible dates to meet - I will respond as soon as possible.
Many thanks

Best wishes
Katy

[Quoted text hidden]

[redacted] Tue, Apr 30, 2013 at 10:45 AM

Good morning Katy,

Many thanks for your email.

I'm glad you are happy with the first model.

The model will be scheduled in for week commencing 13th May 2013.

As for the cost for the first model, it has been calculated to be £741.32 + VAT.

Please could you let me know if you are happy with this cost and I will request the financial paperwork to be raised.

Please could you let me know who will be on the paperwork/invoice (I.e. yourself or the funding body etc), plus anything else you need us to take into consideration.....

As for a date to sit down to discuss the next stage, both myself and Richard are available on Friday 17th May 2013 in the morning.

Could I suggest a 10:30am meeting like before??

If we can get the paperwork through quickly, you might be able to pick up the finished first model then too.....

I look forward to hearing from you .

Best regards,

James.

[redacted]
Sent: 29 April 2013 09:53
To: Bradbury, James; Davies, Richard

[Quoted text hidden]

[Quoted text hidden]

[redacted] Tue, Apr 30, 2013 at 11:10 AM

Hi James,
this is all great - fantastic news.
Re the cost, its slightly higher than I expected - but I'm happy for you to request the paperwork.
Make the invoice to me - and put my name on the paperwork as follows: Katy Connor (ref/ BU Santander PGR Bursary)

We can discuss the cost of the other prints when we meet.
17th May is a good date for me - so yes, 10.30 like before. I may also be free to come and video some of the printing process that week (except wednesday)

Thanks and best wishes
Katy
[Quoted text hidden]

[redacted] Tue, Apr 30, 2013 at 11:13 AM

Ps. If you could send through a copy of the invoice to me asap, then I will be able to request funds via BU as soon as possible.
I can also speak to finance tomorrow when I'm down at Bournemouth.
Thank you,
Katy
[Quoted text hidden]

[redacted] Tue, Apr 30, 2013 at 3:48 PM

Good afternoon Katy,

I have requested for the financial paperwork to be raised.

You should receive this through the post within the next 2 weeks.

I will go ahead and book up a meeting room for the 17th May 2013.

As always please feel free to contact me if you have any further questions.

Best regards,

James.

[redacted]
Sent: 30 April 2013 11:11

[Quoted text hidden]

[Quoted text hidden]

[redacted] Tue, Apr 30, 2013 at 4:05 PM

Hi, Good afternoon James
Thank you - thats great news.
Can I just check that you have the correct address for the invoice as I moved house last summer?

[redacted]

Studio: Spike Island - Studio 94
133 Cumberland Road, Bristol BS1 6UX

Best wishes
Katy

Sent from my iPhone
[Quoted text hidden]

[redacted] Tue, Apr 30, 2013 at 4:05 PM

Hi Katy,

I have requested your studio address, so it will be going to that one!!!

Best regards,

James.

[redacted]
Sent: 30 April 2013 16:06

[Quoted text hidden]

[Quoted text hidden]

[redacted] Tue, May 21, 2013 at 2:55 PM

Good afternoon Katy,

I hope you had a good weekend.

Just thought I would email you to confirm I have boxed up your work which includes diagrams and all the equipment you will need to assembly your work.

I have just put it into the University postal system, so with any luck you should receive it on Thursday or Friday this week.

Please could I ask if you could email me to confirm you have received it and it is all safe that would be fantastic.

As promised I will send some information through to you by the end of the week regarding the next part of your project.

Best regards,

James.

[redacted]
Sent: 30 April 2013 16:06

[Quoted text hidden]

[Quoted text hidden]

[redacted] Tue, May 21, 2013 at 3:16 PM

Hi James, Hi Richard
Good afternoon and thanks for your email James - I hope the modelling is going well.
I'm really looking forward to receiving the work - so will email you once it arrives,

I've just been informed that the dates for my residency have been changed - which means I'll be in Bristol

next week
and I'll be away in Scotland during the first two weeks of June [Mon 3rd - Thurs 13th June].
However I think this still leaves us plenty of time to get the remaining two prints completed before the end of July.

Speak again soon -
Thanks and all the best

Katy

[Quoted text hidden]

Gmail [redacted]

C230 P003 - CALM (University of Exeter) - Project update.

7 messages

[redacted] Fri, May 24, 2013 at 2:26 PM

Hi Katy,

I hope you are well.

As promised, please find attached an image from the new section we spoke about for the next stage of your project.

The size of the section is 222 x 193 x 127mm (x,y,z). We can increase the height of the section if you so wish.

I have managed to offset the spikes by 1mm to form the thickness, but I cannot thicken it up any more without losing some of the details (spikes).

You can see on the image red triangles. These are "defects" in the geometry created from the original source file and subsequent operations.

I have run a simulation on this section as it stands and it initially looks to be ok, however I would category this as "high risk".

What I am trying to say is I do not know if the section will form. Only by building it will we see if this is possible.

As a rough guide, this section would cost about £350 + VAT to manufacture.

Please let me know your thoughts.....

I am away next week, but please feel free to liaise with Richard if you have any further questions.

I hope you have a good bank holiday weekend.

Best regards,

James.

[redacted] Centre for Additive Layer Manufacturing (CALM) - Business

Technology Centre, University of Exeter, [redacted]

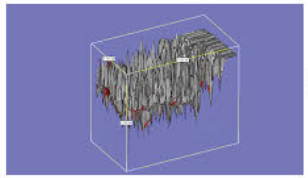
[redacted]

The Centre for Additive Layer Manufacturing (CALM) is funded by the SouthWest Regional Development Agency and the European Regional development fund and partnered with EADS Ltd.

European Regional Development Fund Investing in your Future

South West ERDF COMPETITIVENESS AND EMPLOYMENT PROGRAMME

South West RDA



new_section_image1.jpg
139K

Katy Connor [redacted] Sun, May 26, 2013 at 3:05 PM
To [redacted]
Cc [redacted]

Hi James, Hi Richard
Many thanks for your email - and for sending through the box with the print/glue/mask and directions inside. It has safely arrived in the studio - thank you.

I'm very happy with the section you've selected here - and with the size/scale. I'd be happy for you to

raise all the paperwork and go ahead with the preparations.
My only question is a technical one - in that would making this section at a bigger scale make it easier to print perhaps? I'm sure you've already considered this though.

As the dates for my residency have changed, I'll now be away from 3rd -14th June.
Please let me know what days you're planning on printing so that I can come and film the build as we discussed.
At the moment, all dates after 24th June are all free for me to come and film - I only have my PhD progression exam to prepare for.

I'm also aware that we have up to 31st July to spend the remaining monies - but we can crack on with this once I'm back in June.
Thanks again for all your help with this -
Have a great bank holiday

Best wishes
Katy
[Quoted text hidden]

Bradbury, [redacted] Mon, Jun 3, 2013 at 12:34 PM
To: [redacted]
Cc: [redacted]

Good afternoon Katy,

I'm glad to hear you received the box with all the extra's.

I would love to see a photo of the final part once you have finished with it.....

As for the size of the next section, it is the biggest we can build it at, unless I reduce the overall area of the section, then rescale accordingly.

As for a date of the build, please could I suggest Tuesday 25th June 2013.

This still gives us a month to complete the remaining work and also fits in well with both mine and yours work schedule.

I will be able to set up the build on the Monday, ready for the part to build during Tuesday.

Please let me know if this is ok?

On another subject, I have received an email from Zoe Tissandier confirming she is happy for you to have her contact details and contact her regarding the filming:

[redacted]

[redacted]

Best regards,

James.

From: [redacted]
Sent: 26 May 2013 15:06
To: Bradbury, James
Cc: Davies, Richard
Subject: Re: C230 P003 - CALM (University of Exeter) - Project update.

[Quoted text hidden]

Katy Connor <[redacted] Tue, Jun 4, 2013 at 9:08 AM
To: "[redacted]
Cc: "[redacted]

Hi James,
Good morning and thanks for your email. I hope you had a nice week :)

I'm very happy to go ahead with the build and that's great on the date for the work - I've put it in my diary - please let me know what time to arrive at the lab, so as I can set up to film before production starts.
Thanks also for Zoe's details - I'll contact her once I'm back from Scotland.

Very best wishes
Katy

Sent from my iPhone
[Quoted text hidden]

> [Quoted text hidden]
>
> [Quoted text hidden]
> [Quoted text hidden]
>
> <image001.jpg> <image002.jpg> <image003.png>

[redacted] Tue, Jun 4, 2013 at 9:17 AM

[redacted]

Good morning Katy,

Many thanks for your email.

I have blocked out that date so we will run your work then.

Because the build will be 24 hours plus, you will only be able to video the middle section throughout the day and not the entire build process.

As far as a time is concerned, if you can get here any time after 9:30am you will be able to set up and record throughout the day.

I hope this is ok.

In the mean time I will go ahead and generate an accurate cost for you to review.

Please give me a shout if you have any further questions.

Best regards,

James.

From: [redacted]
Sent: 04 June 2013 09:09

[Quoted text hidden]

[Quoted text hidden]

[redacted] Tue, Jun 4, 2013 at 4:39 PM

Good afternoon Katy,

Please take a look and let me know if you are happy with this cost and if you have any questions.

If you could let me know I will get an official quotation sent out to you.

Contact – Katy Connor

Company Address: Studio 94, Spike Island; 133, Cumberland Road, Bristol, BS1 6UX

[redacted]

CALM ref. Number C230-P003

CALM description- Manufacture of section 2 of the AFM

Source files:

*untitled force 2_fixedpartial_cut_1_Rescaled(750).stl (x1 Qty)

Manufacture using EOS P100 Laser Sintering System using Polyamide 12 (PA12):

Total cost for manufacturing = £335.83 + VAT

*Generated from original file "untitled force 2_fixedpartial.stl"

Please let me know if you have any further questions.

Best regards,

James.

From: Bradbury, James
Sent: 04 June 2013 09:18
To: 'Katy Connor'
Cc: Davies, Richard; James, Ed

Subject: RE: C230 P003 - CALM (University of Exeter) - Project update.

Good morning Katy,

Many thanks for your email.

I have blocked out that date so we will run your work then.

Because the build will be 24 hours plus, you will only be able to video the middle section throughout the day and not the entire build process.

As far as a time is concerned, if you can get here any time after 9:30am you will be able to set up and record throughout the day.

I hope this is ok.

In the mean time I will go ahead and generate an accurate cost for you to review.

Please give me a shout if you have any further questions.

Best regards,

James.

[redacted]

Sent: 04 June 2013 09:09

[Quoted text hidden]

[Quoted text hidden]

[redacted] Tue, Jun 4, 2013 at 6:57 PM

Hi James
Thanks for your email - yes, I can confirm that this is all fine and I'm happy to go ahead.

Best wishes

Katy

Sent from my iPhone
[Quoted text hidden]

Gmail by Google [redacted]

C230 P003 (CALM - University Of Exeter): Build confirmation

10 messages

[redacted] Fri, Jun 21, 2013 at 1:56 PM

Good afternoon Katy,

I hope you are well.

I just thought I would check to see if everything was still ok for next week (Tuesday 25th June).

I am planning to prepare and set up everything on Monday ready for Tuesday, so if you just confirm you will be here on Tuesday that would be fantastic.

Best regards,

James.

[redacted], Centre for Additive Layer Manufacturing (CALM) - Business

Technology Centre, University of Exeter, [redacted] 4QF

[redacted]

The Centre for Additive Layer Manufacturing (CALM) is funded by the SouthWest Regional Development Agency and the European Regional development fund and partnered with EADS Ltd.

European Regional Development Fund Investing in your Future

South West ERDF Competitiveness and Employment Programme

South West RDA

[redacted] Fri, Jun 21, 2013 at 4:37 PM

Hi James
Good afternoon - thank you for your email - and yes I can confirm I will be coming on Tuesday.
I may drive down actually depending on how many cameras/tripods I bring - so please let me know how I should go about parking - if that would be ok?

I'm aiming to arrive around 9.30am but certainly before 10am.

Have a good weekend,
Bests
Katy

Sent from my iPhone

On 21 Jun 2013, at 13:56, "Bradbury, [redacted]

> Good afternoon Katy,
>
> I hope you are well.
>
> I just thought I would check to see if everything was still ok for next week (Tuesday 25th June).
>
> I am planning to prepare and set up everything on Monday ready for Tuesday, so if you just confirm you will be here on Tuesday that would be fantastic.
>
> Best regards,
>
> James.
>
> ---
>
> Mr James Bradbury, Research and Application Engineer, Centre for Additive Layer Manufacturing (CALM) - Business
>
> Technology Centre, University of Exeter, [redacted]

EX4 4QF

[redacted]

The Centre for Additive Layer Manufacturing (CALM) is funded by the SouthWest Regional Development Agency and the European Regional development fund and partnered with EADS Ltd.

<image001.jpg> <image002.jpg> <image003.png>

Bradbury, James [redacted] Mon, Jun 24, 2013 at 10:35 AM
To: [redacted]
Cc [redacted]

Good morning Katy,

Just to confirm, I have reserved a car parking space for you for tomorrow.

Please find a link below for information to get to the Campus. The car parking space will be in the small car park opposite the CALM reception.

www.exeter.ac.uk/calm/contact

I look forward to seeing you tomorrow.

Best regards,

James.

From: Katy Connor [redacted]
Sent: 21 June 2013 16:38

To: Bradbury, James
Cc: Davies, Richard
Subject: Re: C230 P003 (CALM - University Of Exeter): Build confirmation

[Quoted text hidden]

[redacted] Mon, Jun 24, 2013 at 11:06 AM

Good Morning
Thank you for reserving a car parking space James - I look forward to seeing you both tomorrow,

Best wishes
Katy

Sent from my iPhone
[Quoted text hidden]

[redacted] Wed, Jun 26, 2013 at 12:29 PM

Hi Katy,

I hope yesterday went well and you managed to get all the footage you wanted for your project.

Good news on the part. Please see attached.

The part looks good and there is no sign of that problem we had at the beginning of the build.

However, due to the data there is a number of small holes throughout the part.

Please let me know your thoughts and which address you would like me to send it too?

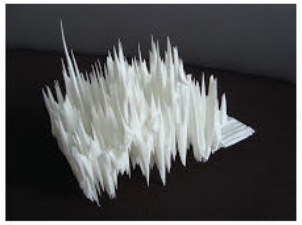
Best regards,

James.

From: [redacted]
Sent: 24 June 2013 11:07

[Quoted text hidden]

[Quoted text hidden]



DSC09915.JPG
2618K

[redacted] Wed, Jun 26, 2013 at 1:12 PM

Hi James, Hi Richard

Thank you for yesterday, I'm just looking through all the footage now. It was really great to see (and film) the process in action - but somehow I still can't quite believe that the object looks this crazy!

What a relief that the print has emerged in one piece though. Could you please send it to my studio address - which is Studio 94, Spike Island, Bristol BS1 6UX?

As I mentioned yesterday, there is now a final £1000 left to develop the last piece/s of work (excl. VAT) but do we have a bit more time to consider this now as the spend deadline has been extended a little.

Thanks again - and I look forward to receiving the print and speaking again soon.
Best wishes
Katy

Sent from my iPhone
[Quoted text hidden]

<DSC09915.JPG>

[redacted] Thu, Jun 27, 2013 at 9:36 AM

Good morning Katy,

Just to let you know I have just put your part in the postal system.

With any luck you should receive it either tomorrow or Monday at the latest.

Please could you email me to confirm you have safely received it and if you have any further questions?

Best regards,

James.

From: [redacted]
Sent: 26 June 2013 13:12

[Quoted text hidden]

[Quoted text hidden]

[redacted] Fri, Jun 28, 2013 at 3:10 PM

Hi - just a quick note to let you know that the print has arrived safe and sound, and I'm very happy with it!

Have great weekend,
Best wishes
Katy

Sent from my iPhone
[Quoted text hidden]

[redacted] Wed, Jul 17, 2013 at 2:24 PM

Good afternoon Katy,

I hope you are well and enjoying all this sun we have been having?

I thought I would just email you to see if you have had any further thoughts on the next stage of your project.

I am aware that we are approaching the summer and with people on holiday etc we need to be thinking ahead now to ensure we meet your time scales.

Best regards,

James.

From: [redacted]
Sent: 28 June 2013 15:11

[Quoted text hidden]

[Quoted text hidden]

[redacted] Fri, Jul 19, 2013 at 1:13 PM

Hi James, Hi Richard
Good afternoon, I hope you're both well and enjoying this fine weather too -
(it's a little hot here in the studio - but I do have a fan so I'm not complaining at all..)

Thanks for your email James - I'm extremely happy with all the ALM prints produced so far, especially the last one in June.
I've been considering where to go next with the project .. and I have some exciting news.
Having applied for a further (final) bursary from Bournemouth University/Santander, I'm pleased to say that this application has been successful!

This means that we now have £3000 (£2500 actual + VAT) to spend on the work - which will enable us to take the project to final completion.
With your cooperation, I would like to complete the project, at absolute latest by April 2014. My PhD is expected to be complete by October 2014.

I have my PhD progression exam on 5th August so, I would like to wait until after then before deciding where to go next - if that is ok with you both?
I understand that you both have summer holiday schedules - so the extra money means we have more time to experiment further, and takes the pressure off a little. Please let me know if this all sounds fine to you - as I hope it fits with the strategic aims of the CALM.

Finally, I've also been having talks with the curator of 3DPrintShow (Carmen Salas) - [thanks for the info Richard] -
it's early days but she may include some of the work...

Well, hope you both have a great weekend - and I look forward to speaking again soon,

Very best wishes
Katy

Katy Connor
Artist | PhD candidate in Experimental Media

[redacted]

Spike Island Studios, Bristol
[redacted]

[Quoted text hidden]

Gmail [redacted]

RE: C230 (CALM - University Of Exeter): Project update

5 messages

Bradbury, James [redacted] Wed, Sep 4, 2013 at 12:15 PM
To: Katy Connor <[redacted]
Cc [redacted]

Good afternoon Katy,

I hope you had a relaxing summer and did well on your exams.

I thought I would just email you to see if you have thought any more about your next project and when you would hope to start this?

If you need any further information from either myself or Richard please do not hesitate to contact us.

Best regards,

James.

From: Katy Connor [redacted]
Sent: 19 July 2013 13:13
To: Bradbury, James
Cc: Davies, Richard
Subject: Re: C230 P003 (CALM - University Of Exeter): Build confirmation

Hi James, Hi Richard

Good afternoon, I hope you're both well and enjoying this fine weather too -
(it's a little hot here in the studio - but I do have a fan so I'm not complaining at all..)

Thanks for your email James - I'm extremely happy with all the ALM prints produced so far, especially the last one in June.
I've been considering where to go next with the project .. and I have some exciting news.
Having applied for a further (final) bursary from Bournemouth University/Santander, I'm pleased to say that this application has been successful!

This means that we now have £3000 (£2500 actual + VAT) to spend on the work - which will enable us to

take the project to final completion.
With your cooperation, I would like to complete the project, at absolute latest by April 2014. My PhD is expected to be complete by October 2014.

I have my PhD progression exam on 5th August so, I would like to wait until after then before deciding where to go next - if that is ok with you both?
I understand that you both have summer holiday schedules - so the extra money means we have more time to experiment further, and takes the pressure off a little. Please let me know if this all sounds fine to you - as I hope it fits with the strategic aims of the CALM.

Finally, I've also been having talks with the curator of 3DPrintShow (Carmen Salas) - [thanks for the info Richard] -
it's early days but she may include some of the work...

Well, hope you both have a great weekend - and I look forward to speaking again soon,

Very best wishes

Katy

Katy Connor

Artist | PhD candidate in Experimental Media

[redacted]

Spike Island Studios, Bristol
[redacted]

On Wed, Jul 17, 2013 at 2:24 PM, Bradbury, James [redacted]

Good afternoon Katy,

I hope you are well and enjoying all this sun we have been having?

I thought I would just email you to see if you have had any further thoughts on the next stage of your project.

I am aware that we are approaching the summer and with people on holiday etc we need to be thinking ahead now to ensure we meet your time scales.

Best regards,

James.

From: Katy Connor [redacted]
Sent: 28 June 2013 15:11

To: Bradbury, James
Cc: Davies, Richard
Subject: Re: C230 P003 (CALM - University Of Exeter): Build confirmation

Hi - just a quick note to let you know that the print has arrived safe and sound, and I'm very happy with it!

Have great weekend,

Best wishes

Katy

Sent from my iPhone

On 27 Jun 2013, at 09:36, "Bradbury, James" [redacted]

> Good morning Katy,
>
> Just to let you know I have just put your part in the postal system.
>
> With any luck you should receive it either tomorrow or Monday at the latest.
>
> Please could you email me to confirm you have safely received it and if you have any further questions?
>
> Best regards,
>
> James.

From: Katy Connor [redacted]
Sent: 26 June 2013 13:12
To: Bradbury, James
Cc: Davies, Richard
Subject: Re: C230 P003 (CALM - University Of Exeter): Build confirmation

Hi James, Hi Richard

Thank you for yesterday, I'm just looking through all the footage now. It was really great to see (and film) the process in action - but somehow I still can't quite believe that the object looks this crazy!

What a relief that the print has emerged in one piece though. Could you please send it to my studio address - which is Studio 94, Spike Island, Bristol BS1 6UX?

As I mentioned yesterday, there is now a final £1000 left to develop the last piece/s of work (excl. VAT) but do we have a bit more time to consider this now as the spend deadline has been extended a little.

Thanks again - and I look forward to receiving the print and speaking again soon.

Best wishes

Katy

Sent from my iPhone

On 26 Jun 2013, at 12:29, "Bradbury, James" [redacted]

> Hi Katy,
>
> I hope yesterday went well and you managed to get all the footage you wanted for your project.
>
> Good news on the part. Please see attached.
>
> The part looks good and there is no sign of that problem we had at the beginning of the build.

However, due to the data there is a number of small holes throughout the part.

Please let me know your thoughts and which address you would like me to send it too?

Best regards,

James.

From: Katy Connor [redacted]
Sent: 24 June 2013 11:07
To: Bradbury, James
Cc: Davies, Richard
Subject: Re: C230 P003 (CALM - University Of Exeter): Build confirmation

Good Morning

Thank you for reserving a car parking space James - I look forward to seeing you both tomorrow,

Best wishes

Katy

Sent from my iPhone

On 24 Jun 2013, at 10:35, "Bradbury, James" [redacted] wrote:

> Good morning Katy,
>
> Just to confirm, I have reserved a car parking space for you for tomorrow.
>
> Please find a link below for information to get to the Campus.
> The car parking space will be in the small car park opposite the CALM reception.
>
> [redacted]

I look forward to seeing you tomorrow.

Best regards,

James.

From: Katy Connor [redacted]
Sent: 21 June 2013 16:38
To: Bradbury, James
Cc: Davies, Richard
Subject: Re: C230 P003 (CALM - University Of Exeter): Build confirmation

Hi James

Good afternoon - thank you for your email - and yes I can confirm I will be coming on Tuesday.

I may drive down actually depending on how many cameras/tripods I bring - so please let me know how I should go about parking - if that would be ok?

I'm aiming to arrive around 9.30am but certainly before 10am.

Have a good weekend,

Bests

Katy

Sent from my iPhone

On 21 Jun 2013, at 13:56, "Bradbury, James" [redacted]

> Good afternoon Katy,
>
> I hope you are well.

I just thought I would check to see if everything was still ok for next week (Tuesday 25th June).

I am planning to prepare and set up everything on Monday ready for Tuesday, so if you just confirm you will be here on Tuesday that would be fantastic.

Best regards,

James.

Mr James Bradbury, Research and Application Engineer, Centre for Additive Layer Manufacturing (CALM) - Business

Technology Centre, University of Exeter, Harrison Building, North Park Road, EXETER, DEVON. EX4 4QF

[redacted]

The Centre for Additive Layer Manufacturing (CALM) is funded by the SouthWest Regional Development Agency and the European Regional development fund and partnered with EADS Ltd.

<image001.jpg> <image002.jpg> <image003.png>

<DSC09915.JPG>

[redacted] Tue, Nov 5, 2013 at 3:33 PM

Dear James and Richard,

Firstly my sincere apologies for not being in touch sooner. I've had rather a surprising summer - my exams went very well, thank you - and I can now also reveal, that I am 4 months pregnant! Although quite a surprise, we're slowly getting used to the idea...

As I'm sure you can appreciate, this rather changes the demands on my PhD workload and also these outstanding works that are still to be completed at CALM. Obviously I am dependent on yourselves and your own time-frames as to how to best proceed with this - but I would like (if at all possible) to have completed all the build work by January 2014, as the baby is due in April (!) .

That said, I think it would be a good idea to meet with you at Exeter as soon as possible to discuss the next stage of the project and how best to proceed from here? Please could you let me know possible dates when you would be free to meet up?
As I stated in a previous mail, we have £3000 (£2500 actual + VAT) to spend on the work - which will come direct from Bournemouth University.

The other news is that my first piece (commissioned through CALM and Exeter Phoenix) will be shown as part of the art gallery at 3DPrintshow exhibition in London this weekend. Please let me know if either of you will be attending, as I hope to go down on the Thursday (7th Nov) and it would be nice to see you.

Apologies again for not being in touch sooner, but I look forward to hearing from you,

Very best wishes
Katy

Katy Connor
Artist | PhD candidate in Experimental Media

[redacted]

w. katyconnor.com

Spike Island Studios, Bristol
[redacted]

On Wed, Sep 4, 2013 at 12:15 PM, Bradbury [redacted]

> Good afternoon Katy,
>
> I hope you had a relaxing summer and did well on your exams.
>
> [Quoted text hidden]

On Wed, Jul 17, 2013 at 2:24 PM, Bradbury [redacted]

> [Quoted text hidden]

~WRD000.jpg
1K

Bradbury, James [redacted] Thu, Nov 7, 2013 at 12:00 PM
To: Katy Connor [redacted]
Cc: "Davies, Richard" [redacted]

Good morning Katy,

A big congratulations to you and your partner from both of us here at CALM.

It must be a very exciting yet busy time for you!

And well done for the news on exhibiting today at the 3DPrintshow in London.

I hope you enjoy it.

Richard went last year, but unfortunately no one will be there this year, so please feel free to fly the flag for CALM.....

Regarding your remaining funding and timescales, we will try our best, however it will be January by the time we can do the work.

I would however still think it would be worthwhile arranging a meeting for this side of Christmas to sit down and discuss the next phase of your project.

I have listed below some days we are available:

- Tuesday 3rd December 2013 – Anytime
- Wednesday 4th December 2013 – Anytime
- Wednesday 11th December 2013 – Morning only

Please let me know if any of these dates are convenient for you?

Best regards,

James.

———————

Mr James Bradbury, CALM Co-ordinator and Development Researcher, Centre for Additive Layer Manufacturing (CALM) - Business Technology Centre.

[redacted]

———————

[redacted]

———————

The Centre for Additive Layer Manufacturing (CALM) is funded by the SouthWest Regional Development Agency and the European Regional development fund and partnered with EADS Ltd.

European Regional Development Fund: Investing in your Future | University of Exeter Centre for Additive Layer Manufacturing

---

From: Katy Connor [redacted]
Sent: 05 November 2013 15:33
To: Bradbury, James
Cc: Davies, Richard
Subject: Re: C230 (CALM - University Of Exeter): Project update

Dear James and Richard,

Firstly my sincere apologies for not being in touch sooner. I've had rather a surprising summer - my exams went very well, thank you - and I can now also reveal, that I am 4 months pregnant! Although quite a surprise, we're slowly getting used to the idea...

As I'm sure you can appreciate, this rather changes the demands on my PhD workload and also these outstanding works that are still to be completed at CALM. Obviously I am dependent on yourselves and your own time-frames as to how to best proceed with this - but I would like (if at all possible) to have completed all the build work by January 2014, as the baby is due in April (!) .

That said, I think it would be a good idea to meet with you at Exeter as soon as possible to discuss the next stage of the project and how best to proceed from here? Please could you let me know possible dates when you would be free to meet up?
As I stated in a previous mail, we have £3000 (£2500 actual + VAT) to spend on the work - which will come direct from Bournemouth University.

The other news is that my first piece (commissioned through CALM and Exeter Phoenix) will be shown as part of the art gallery at 3DPrintshow exhibition in London this weekend. Please let me know if either of you will be attending, as I hope to go down on the Thursday (7th Nov) and it would be nice to see you.

Apologies again for not being in touch sooner, but I look forward to hearing from you,

Very best wishes

Katy

Katy Connor

Artist | PhD candidate in Experimental Media

[redacted]

Spike Island Studios, Bristol
[redacted]

[Quoted text hidden]

Katy Connor [redacted] Fri, Nov 8, 2013 at 6:51 PM
To: "Bradbury, James" [redacted]
Cc: "Davies, Richard" [redacted]

Dear James and Richard,
Thank you for your email - and your congrats!

I completely understand regarding time-scales, so no problem at all there..

I'm sorry that I couldn't have met with you sooner, but I've been quite poorly over the last couple of months. However, things are much better now - so I think we could meet on Wednesday 4th December, say at 11am? or 1pm?

I hope this suits -
Look forward to seeing you then,

Best wishes
Katy
[Quoted text hidden]

[redacted] Mon, Nov 11, 2013 at 9:36 AM

Good morning Katy,

I have reserved a meeting room for Wednesday 4th December 2013 at 11am here at CALM.

We look forward to seeing you then.

Best regards,

James.

Mr James Bradbury, CALM Co-ordinator and Development Researcher, Centre for Additive Layer Manufacturing (CALM) - Business Technology Centre.

[redacted]

[redacted]

Gmail by Google [redacted]

C230 P004: CALM (University of Exeter) - Cost and project ideas

3 messages

Bradbury, James [redacted] Fri, Dec 20, 2013 at 10:50 AM
To: Katy Connor [redacted]

Good morning Katy,

Apologies for leaving this email so late, but hopefully you may have an opportunity to take a look at this over the Christmas period and comment where required.

From our project meeting a couple of weeks ago, please find attached a few images of the section you identified you would like building next.

I have also increased the overall size of the new section to be approximately 150mm x 220mm x 240mm.

I have also calculated that this would cost £854.95 + VAT to build.

I have also (there is an awful lot of "I have also's") blocked out the last two weeks in January 2014 to build this section for you.

I hope this all makes sense!

It's my last day today, but will be back in the office week commencing Monday 6th January 2014, so will pick up any emails then.

Once again, please could I take this opportunity to wish you and your partner a very special Christmas and look forward to working with you once again in 2014.

Best regards,

James.

Mr James Bradbury, CALM Co-ordinator and Research Fellow, Centre for Additive Layer Manufacturing (CALM) - Business Technology Centre.

University of Exeter, [redacted]

[redacted]

The Centre for Additive Layer Manufacturing (CALM) is funded by the SouthWest Regional Development Agency and the European Regional development fund and partnered with EADS Ltd.

European Regional Development Fund: Investing in your Future

University of Exeter Centre for Additive Layer Manufacturing

4 attachments

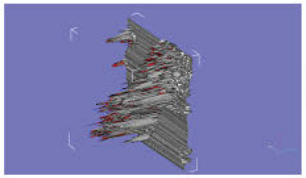


image1_isoview.jpg
139K

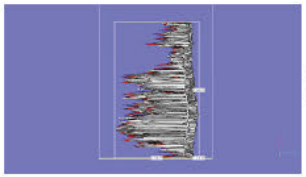


image1_sideview-dims.jpg
122K

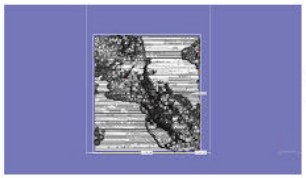


image1_topsideview-dims.jpg
162K

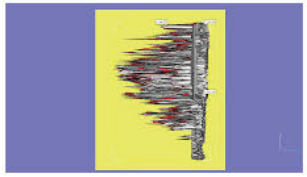


image1_topview-dims.jpg
130K

Katy Connor [redacted] Mon, Jan 6, 2014 at 2:32 PM
To: [redacted]

Dear James,
Thank you for your email - I'm very happy to go ahead with the work as you have proposed.
I'm currently away in Berlin (until 12th Jan) but I'm available via email - so I can respond to any further questions/etc you may have asap.

Wishing you and everyone at CALM a Happy New Year for 2014!

Look forward to speaking with you again soon,
Best wishes
Katy
[Quoted text hidden]

Bradbury, James <J.P.Bradbury@exeter.ac.uk> Tue, Jan 7, 2014 at 12:18 PM
To: Katy Connor <katyconnor23@gmail.com>

Good afternoon Katy,

And a very happy new year to you too.

Just to let you know I have requested the finance department to get the contract sent out to you so you should receive this within the next week or so.

I will now go ahead and schedule in your part in for the end of this month and will let you know when that will be.

In the mean time please could you have a think about what you would like your next part to be. Please let me know if you have any questions.

I will be in contact shortly.

Best regards,

James.

Mr James Bradbury, CALM Co-ordinator and Research Fellow, Centre for Additive Layer Manufacturing (CALM) - Business Technology Centre.

University of Exeter, [redacted]

[redacted]

The Centre for Additive Layer Manufacturing (CALM) is funded by the SouthWest Regional Development Agency and the European Regional development fund and partnered with EADS Ltd.

European Regional Development Fund: Investing in your Future | University of Exeter Centre for Additive Layer Manufacturing

---

From: Katy Connor [redacted]
Sent: 06 January 2014 14:33
To: Bradbury, James
Subject: Re: C230 P004: CALM (University of Exeter) - Cost and project ideas

[Quoted text hidden]

Gmail [redacted]

Thank you again - and next section

5 messages

Katy Connor [redacted] Thu, Feb 6, 2014 at 4:33 PM
To: "Bradbury, James" [redacted]
Cc: [redacted]

Hi James, Good afternoon,
I hope it has stopped raining (at least for a bit) there..

Thank you again for the interview yesterday -
I'm currently transcribing it all now - please rest assured, you sound very knowledgeable, but I hope to send you a copy via email that you can check through in the next few days ...

I've attached here 3 images of the next print area we discussed - again, any problems please be in touch.

I hope the current print will behave itself in the machine this time.
Once it is finished, please could you send it to my home address, which is

[redacted]

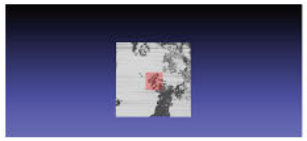
Thanks again James,
Speak to you soon,

Best wishes
Katy

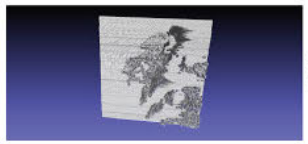
Katy Connor
Artist | PhD candidate in Experimental Media
[redacted]

Spike Island Studios, Bristol
[redacted]

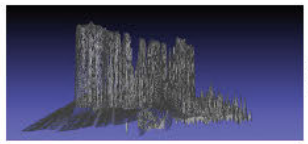
3 attachments



1_Untitled.jpg
210K



2_Untitled.jpg
475K



3_Untitled.jpg
461K

Bradbury, James [redacted] Thu, Mar 13, 2014 at 1:34 PM
To: Katy Connor [redacted]
Cc: [redacted]

Good afternoon Katy,

I hope you are well and received the last print ok?

Have you been able to get out in the sun??

Following on from your last request, please find attached some images of the last print with dimensions etc.

The cost to manufacture this next print will cost £969.57 + VAT.

Please could you let me know if you are happy to proceed or if you have any questions?

Best regards,

James.

Mr James Bradbury, CALM Co-ordinator and Research Fellow, Centre for Additive Layer Manufacturing (CALM) - Business Technology Centre.

University of Exeter, [redacted]

[redacted]

The Centre for Additive Layer Manufacturing (CALM) is funded by the SouthWest Regional Development Agency and the European Regional development fund and partnered with EADS Ltd.

European Regional Development Fund: Investing in your Future

University of Exeter Centre for Additive Layer Manufacturing

From: Katy Connor [redacted]
Sent: 06 February 2014 16:34
To: Bradbury, James
Cc: [redacted]
Subject: Thank you again - and next section

[Quoted text hidden]

---

3 attachments

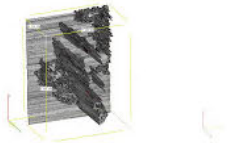


image1.jpg
133K

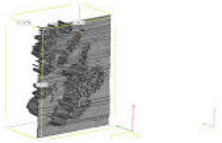


image2.jpg
128K

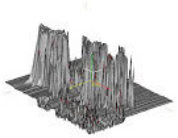


image3.jpg
123K

Katy Connor [redacted] Mon, Mar 24, 2014 at 4:08 PM
To: "Bradbury, James" [redacted]
Cc: [redacted]

Dear James,
Good afternoon, thanks for your email - and sorry for the slight delay in getting back to you - I've actually been in hospital for a few days.
However I'm glad to say that I'm well and everything's absolutely fine with the baby, so I'm just preparing to go on maternity leave at the end of the month. Just so you know, there is a little flexibility with this, as I'll continue to answer all your emails with regard to model builds, deadlines etc. as best as I can.
However if I am in hospital there will inevitably be some delay - so I hope you can be a little bit patient with this.

With regard to the pictures of the print you've proposed, I think they're great and I'd really like you to go ahead with the build. If you can ask Kathleen to get the paperwork to me asap, then I start to get the ball rolling at BU, so payment can start to be processed before I go on mat leave. I'm sure it will all be fine - as they seem to be on the case regards this now.

I have received the last build too, so thank you very much for that - I'm very pleased with it.
I did notice that the "finish" wasn't quite as smooth as the first few prints - and I wondered if there was a reason for this perhaps?
If possible, I'd like the surface finish to be as smooth as possible - but I completely understand if there are difficulties with the build etc. As always, it would be helpful for my research if you could let me know the reasons for any differences - as I'm simply curious to add this to my investigation.
Similarly, if there are any problems with the next build, I wondered if you wouldn't mind taking a photo of any problems?
(for example if you find that the machine has tried to build through the night, and you arrive to find a great mess in the machine the next day?) I know that you might not think this relevant, or you wouldn't want these mistakes/errors to reflect badly on your professionalism - but I can assure you that they would simply be used to add validity to the project, in order to illustrate difficulties with the work.

Finally, it would be really helpful for me if you could sign off the interview transcript as soon as possible - although I do appreciate it's very long and can take a while to read through!!! If you could do this before my maternity leave, then I can send you the final approved print-out along with the ethics clearance paperwork - so that it's all settled and in place.

Thank you so much James - I do hope you're well, and you're not too rushed off your feet - and you're also managing to get everything prepared for your wedding? it must feel like it's very soon now.
Best of luck with it all :)
Any problems, please don't hesitate to be in touch,

Speak again soon,
Very best

Katy

Katy Connor
Artist | PhD candidate in Experimental Media
[redacted]

Spike Island Studios, Bristol
[redacted]

[Quoted text hidden]

Katy Connor [redacted] Tue, Apr 1, 2014 at 3:37 PM
To: "Bradbury, James" [redacted]

Hi James, good afternoon.
I hope you're well?
As I officially start my Maternity Leave today, 1st April, I just wanted to make sure that you received my last email, regarding the paperwork for the new print - and also the interview transcript? I've not had anything through from Kathleen yet, and I'm just aware that it could get overlooked if the baby decides to come early (!)
Thanks - and I hope all is well with you,

Best wishes
Katy

---------- Forwarded message ----------
From: **Katy Connor** [redacted]
Date: Monday, March 24, 2014
Subject: Thank you again - and next section
[Quoted text hidden]

Bradbury, James [redacted] Thu, Apr 3, 2014 at 11:02 AM
To: [redacted]

Good morning Katy,

I'm so sorry I have not got back to you.
I have been off work for the last week with a throat infection and have not been able to process the quotation etc.

I am in the office tomorrow, so will ensure I do this as one of my top priorities.
I will email you as soon as it is done.

I am also aware of a few other outstanding actions for me to do for you and will try and get these done as quickly as possible.

Thank you so much for your patience.

Best regards,

James

Mr James Bradbury, CALM Co-ordinator and Research Fellow, Centre for Additive Layer
[redacted]

[redacted]

The Centre for Additive Layer Manufacturing (CALM) is funded by the SouthWest Regional Development Agency and the European Regional development fund and partnered with EADS Ltd.

From: Katy Connor [redacted]
Sent: 01 April 2014 15:37
To: Bradbury, James; [redacted]
Subject: Fwd: Thank you again - and next section

[Quoted text hidden]

Gmail [redacted]

C230 P005: CALM (University of Exeter)

5 messages

Bradbury, James [redacted] Mon, Jun 16, 2014 at 2:07 PM
To: Katy Connor [redacted]
Cc: [redacted]

Good afternoon Katy,

I hope you are well and the birth of your baby all went well.

I'm so sorry I have not been able to get back to you earlier, but I have just got back from my honeymoon after my wedding.

I have attached a couple of photos of the final section for you.

This section came out first time and the detail is excellent. I'm very happy with this one!

I have just put it in the post to you, addressed to your studio, so with any luck you should receive this within the next couple of days.

Please could you let me know when you receive it and if you have any further questions?

I also realise I have some outstanding actions regarding the transcript and questions relating to the last section you have asked for.

I will endeavour to get this information back to you asap.

Thank you once again for your patience and I will be in touch soon.

Best regards,

James.

Mr James Bradbury, CALM Co-ordinator and Research Fellow, Centre for Additive Layer Manufacturing (CALM) - Business Technology Centre.

[redacted]

[redacted]

[redacted]

The Centre for Additive Layer Manufacturing (CALM) is funded by the SouthWest Regional Development Agency and the European Regional development fund and partnered with Airbus Group Ltd.

European Regional Development Fund: Investing in your Future

University of Exeter Centre for Additive Layer Manufacturing

2 attachments

DSC01788.JPG
2264K

DSC01790.JPG
2564K

Katy Conno [redacted] Thu, Jun 19, 2014 at 6:26 PM
To [redacted]

Hi James,
Good afternoon, and many congratulations on your wedding! I hope you had a lovely day and your honeymoon isn't over just yet.

Thank you for your email/photos - the model looks great, and I'm glad you're pleased with it too!I'll let you know when I pick it up from the studio. And yes, it would be good if you could check through the transcript at some point - when you have the time.

My son Luka was born on 22nd April - so he's nearly 2months old now. He's a happy chap (most of the time anyway) so we're enjoying getting to know him.

Thanks again James,
Will be in touch soon.
Best wishes

Katy
[Quoted text hidden]
--
Katy Connor

Artist | PhD candidate in Experimental Media
[redacted]

Spike Island Studios, Bristol
[redacted]

Katy Connor [redacted] Fri, Jul 4, 2014 at 4:00 PM
To: "Bradbury, James" [redacted]

Dear James
good afternoon, I hope you're well.

I'm writing to let you know that I've received the print - thankyou - and I agree, its really rather nice!
I'm sorry to say that unfortunately, there was a black mark on the underside - like a large black fingerprint - which has proved difficult to remove.
Do you know what this might be? Can you recommend any solvents that are used to clean the nylon without damaging it?

I'll be in touch again soon, once I know my remaining budget and if there are funds left to produce one final print.
I hope the transcript isn't proving to be such a tedious job!!
Look forward to hearing from you James - have a nice weekend,

Best wishes
Katy

[Quoted text hidden]
--
Katy Connor

Artist | PhD candidate in Experimental Media
[redacted]

Spike Island Studios, Bristol
[redacted]

Katy Connor <katyconnor23@gmail.com> Thu, Jul 24, 2014 at 7:04 PM
To: "Bradbury, James" <J.P.Bradbury@exeter.ac.uk>

Dear James,
I hope you're well and managing to enjoy some of this hot weather we've been having lately...?

Having looked at my final budget, I do not think I will be able to build any more of the 3D models - so I just wanted to say thank you to you - for being so accommodating and helpful to me in making these works. I know they have not been easy to build and so I do really appreciate the time that you've spent on them, especially since your workload/responsibilities have changed at CALM in the past year.

Obviously I still have a great deal of work to do to finish my PhD thesis and create the exhibition of my research - but I will keep in touch and let you know when/where the exhibition will take place. I will be away for the next couple of weeks, but if you could let me know when you've finished reading/correcting the transcript, I will be back from 14th August, and will be starting work again the following week.

Thanks again James, I look forward to hearing from you then

Best wishes
Katy
[Quoted text hidden]

Katy Connor [redacted] Wed, Oct 1, 2014 at 5:51 PM
To: "Bradbury, James" [redacted]

Dear James,
Good afternoon, I do hope you're well and that you're settling into the new academic year after a great summer.

I'm pleased to say that some of the ALM printwork we made together will be exhibited next year at Exeter Phoenix (in November 2015). The work is part of an exhibition and conference called "ReDefining Print" and will also feature three other artists' work.

I am also completing my PhD thesis, so if you could let me know when you've corrected the interview transcript, I shall send over the ethics and release forms with final copies of the transcript for you to keep.
I will let you know where and when my exhibition of PhD research will be taking place, nearer the time.

Thanks James, I look forward to hearing from you soon,

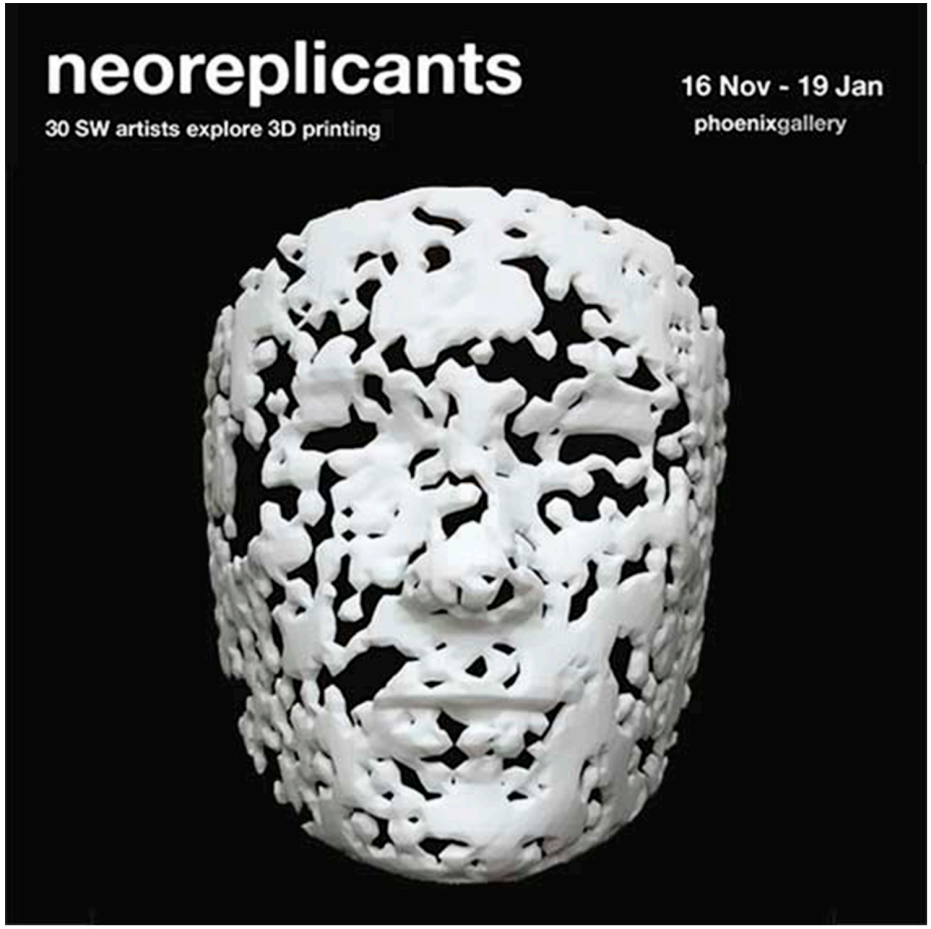
Best wishes

Katy

--
Katy Connor

Artist | PhD candidate in Experimental Media
[redacted]

Spike Island Studios, Bristol
[redacted]



neoreplicants

30 SW artists explore 3D printing

phoenixgallery
Private View: 15 Nov 6pm-8pm
Exhibition continues: 16 Nov – 19 Jan

Neoreplicants brings together the results of a partnership between Exeter Phoenix's annual *Digital Art Commission* and the University of Exeter's *Centre for Additive Layer Manufacturing (CALM).* This opportunity gave thirty South West based visual artists the chance to explore the possibilities offered by the emerging technologies of 3D printing to their art making practice.

Given training and access to CALM's facilities, artists were able to create objects in computer modeling software, that were then printed through a process of laser sintering - whereby granules of a densely packed nylon powder material are welded together by laser, layer-by-layer.

This rapidly developing industrial design technology opens possibilities to create, replicate and adapt complex objects (including bespoke replacement body parts and prosthetics), sharing 3D files on the internet and printing them in a variety of materials. It immediately raises allusions to the utopian/dystopian technologies of science fiction, many now on the cusp of becoming science fact. New possibilities too are inevitable for the creation of art, both as a fabrication technique and as a way to visualise and make tangible the (often abstract) digital information that is ever more pervasive in our lives.

The results of this opportunity reflect a breadth of interest and enquiry; from those seated in formal, manufacturing process to a more conceptual engagement with this emerging technology. For some this offered a completely new approach to their practice, for others an extension of their existing interest in digital formats.

Although many of the works on show exist in the form of experimental sketches, the first step perhaps in understanding the possibilities and potential for further development, some emerge as finished artworks in their own right, and one artist has been selected to develop their concept further into a solo presentation in early 2013.

Participating artists;

Catherine Cartwright | Mat Chivers | Sam Cook | Katy Connor | Maia Conran | Paul Channing | Susie David | Nick Davies | Robin Duttson | Diane Gorvin | Jacqui Harrison | Julie Hewson | Gabrielle Hoad | Nicola Jaberi | Jo Lathwood | Debbie Locke | Stephen Monger | Phillip Oreilly | Wei Ong | Sarah Parks | Josh Randall | Angela Read | Simon Ryder | Caroline Saunders | Helen Snell | Zoe Tissandier | Kasia Turajczyk | Jessica Turrell | Michael Werbicki | Nicci Wonnacot

About CALM:
Based at the University of Exeter, CALM supports many businesses in the South West who are already making use of this technology to develop new products. Individuals, businesses and those working in education are also invited to the exhibition to look at the artwork and its inspirations and to imagine how 3D printing could benefit their own products and process.

Associated Events

Tuesday Collective
Tue 20 Nov, 7.30pm, FREE, limited places – booking advisable.
A discussion about how the development of 3D printing and other new technologies can interface with art making and how each feeds into the other.

European Regional Development Fund: Investing in your Future
University of Exeter
Centre for Additive Layer Manufacturing

exeterphoenix

Appendix 11: *3DPRINTSHOW*

3D PrintShow London: Industry & Design Conference
Art Exhibition: Curator Carmen Salas

7 - 9 November 2013

3D PRINTSHOW 2013

LONDON
7—9 November
THE BUSINESS DESIGN CENTRE

PARIS
15—16 November
CARROUSEL DU LOUVRE

3D PRINTSHOW 2014
COMING TO:

LONDON
PARIS
NEW YORK
DUBAI
SINGAPORE

3D Printshow allows you to experience the world's most talked about future-tech, with live demonstrations, workshops and seminars showcasing design, live music, high fashion, art, food, archaeology, movies and medical science - all produced in 3D print!

www.3dprintshow.com /3dprintshow /3dprintshow /3dprintshow

3D PRINTSHOW

OFFICIAL SHOW PROGRAMME

Contents

WELCOME

What a year this has been.

3D printing has exploded into the public consciousness and we've witnessed incredible developments, from innovative machines to stunning artworks, controversies to a mention from President Obama.

The 3D printing world is an amazing global community and we feel deeply honoured to be involved in such a progressive, pioneering movement.

Our exhibitors and contributors have worked tirelessly to help us create something truly remarkable, and I can not thank them enough. They've been central in our vision of an event where manufacturers forge relationships with artists, the press can meet the unsung heroes of tech and the public gets to see things they can hardly believe.

So whether you're an industry veteran, an emerging designer or a curious passer-by who just wants to see this tech in action, we've produced a show with something for you. We hope that you enjoy your experience as much as we've enjoyed creating it.

Kerry Hogarth
3D Printshow Founder

3D Printshow is honored to feature some of the worlds top 3D print artists. Our gallery this year includes works from:

Corneel Cannaerts	Dann Chetrit	David Van Ness	Davide Prete
Eric van Straaten	Ewald Neuhofer	Frederik de Wilde	Helena Lukasova
Jim Stanis	Johanna Spath & Johannes Tsopanides	Joshua Harker	Katy Conor
Lilia Ziamou	Linlin & Pierre -Yves Jacques	Lionel T Dean	Masters & Munn
Matthew Plummer-Fernandez	Michaella Janse van Vuuren	Monika Horcicová	Nick Ervinck
Peter Patchen	Philip O'Reilly	Sam Thomson	Sophie Kahn
		Tobias Klein	Tomas Medek

3D PRINTSHOW:ARTS GALLERY

André Masters and CJ Munn have embraced 3D printing, combining it with traditional lifecasting and sculpture to create the incredible 'Icarus Had a Sister'. Produced with support from IPF Ltd, they are unveiling this amazing work at 3D Printshow 2013.

mastersandmunn.co.uk
ipfl.co.uk

Art is one of the great markers of an era. From cave paintings to the wonders of ancient Greece, the Renaissance to the hit-and-run works of Banksy, art exists to comment on the time from which it has sprung forth. It gives us a glimpse into the life of a people, not just their daily activities, but where they are, where they see themselves and where they hope to be.

For art to live, technology is the great facilitator, taking the ideas of creative mind and bringing them to be. From the bone, rock and animal fats that our ancient ancestors painted with, to the metal tools, scaffolding and precious materials that were mastered to create works worthy of gods and kings, it is man's ability to find solutions that has opened the door to our imagination a little wider each time.

3D Printing represents one of the most significant enabling technologies of the last fifty years. From the painting to the photograph, the story to the motion picture, the sculpture to the 3D print, technologies have allowed us to capture our world much more accurately and distort it much more convincingly.

With tools, machining, sculpting: traditional crafts opened up a world of expression - but there was a limit to what could be created. With every technology, it's arrival heralds a new movement, it's ubiquity springs forth a legion of imitators and a ceiling becomes obvious – a threshold past which a brave few will aspire. It is the hunger for more, the desire to see further, to reach higher that drives us to work steadily and patiently, indulging the infancy of a technology, willing it forward, and knowing that when the time comes, that which people could only dream of will be in our hands.

3D printed art is significant not because of the printers themselves, no more so than a painting should be thought beautiful in light of the technology of the paintbrush. What is truly exciting is the possibility that it has opened up. That which was but a dream, a vision - that which we were told was impossible to create is now among us.

The door has opened a little wider...

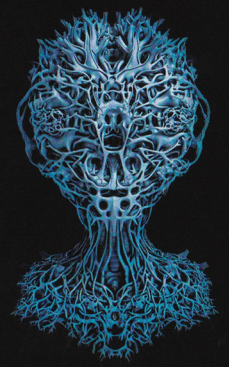
FEATURED ARTISTS

'Anatomica Di Revolutis' by Joshua Harker

JOSHUA HARKER

joshuaharker.com

Joshua Harker is an American artist considered a pioneer and visionary in 3D printed art and sculpture. His series of 'unmakeable' technically complex tangles is credited as the first work to break the 'design & manufacturing possibility threshold'. His pursuit of a process to bring his works into the 3rd dimension culminated after nearly twenty years, in a perfect storm of software development, materials engineering, and 3D printing technology advancements.



'Agneborz' by Nick Ervinck

NICK ERVINCK

nickervinck.com

Fostering a cross-pollination between the digital and the physical, Nick Ervinck explores the boundaries between various media. He applies tools and techniques from new media to explore the aesthetic potential of sculpture, 3D print installations, architecture and design. Through his divergent practice, a strong fascination with the construction of space is noticeable. Not only focusing on the autonomous sculptural object, he also questions its spatial positioning and points to the phenomenological experience and embodiment of space.

We're extremely privileged to be working with some of the worlds top 3D print artists. We've selected four of our most high-profile contributors to profile:

'sekuMoi Mecy' by Matthew Plummer Fernandez

MATTHEW PLUMMER FERNANDEZ

plummerfernandez.com

Matthew Plummer-Fernandez is an artist exploring emerging technology and culture. He uses scanning, digital fabrication and computational approaches to making artefacts, both physical and digital, that often blur the distinction between the two. Combining the disparate disciplines of artistry and coding, he assembles customised software pallettes, creating individualistic works that comment on the cultural markers of our time.

'The Invisible Human' by Tobias Klein

TOBIAS KLEIN

kleintobias.com

Studio Tobias Klein operates in the area between design, art and architecture, across the fields of installation, experimental interactivity and urbanism. Although diverse, the studio's core work maintains a fascination with the construction of space while questioning its modern and static understanding. Through varied works covering different scales and sizing, the studio achieves a re-positioning of this understanding in the context of embodiment, perception and projection.

Appendix 12:

Promotional video stills from 3D Systems' *Sinterstation*

These stills from 3D Systems' promotional video for *Sinterstation* illustrate an idealised 'seamless divide' between the virtual object (above) and its double (below), using a global metaphor. (3D Systems. 2012)

Full video available from
http://www.youtube.com/watch?v=IC0uVO_uT0s
[Accessed 18 October 2012]

Appendix 13:
Email correspondence with Professor Genhua Pan

Professor of Spintronics and Nanomagnetism
School of Computing, Electronics and Mathematics
Plymouth University
November 2012

Gmail by Google [redacted]

AFM Scan imagery

Genhua Pan [redacted] Wed, Nov 28, 2012 at 9:40 AM
To: katy connor [redacted]

Hi Katy,

Good to hear from you after such a long time.

I am not quite sure why you get double sided structure, unless you combined two channels of data in one. The AFM stores the forward scan image and backward scan image separately and they are effectively mirror images to each other if the machine is perfectly optimised. However they would look different if not. If you put both forward scan and backward scan images in one, you may get a two sided image. Otherwise, I don't how you get that.

Hope this helps.

Regards

Genhua

From: katy connor [redacted]
Sent: 27 November 2012 21:20
To: Genhua Pan
Subject: Fwd: AFM Scan imagery

Dear Genhua,
I hope you are well.

I took part in an AFM workshop in July 2010 with iDAT/Prof. Mike Philips - and with your help - we made some data/images from using the microscope.
You previously sent through some information about the size and scale of the data - so thank you for that.

I have recently started a PhD, (Supervisor, Prof Mike Philips), and I have been making some 3-D prints (Rapid Prototypes) at Exeter University from this scan data. I'm writing now, as I'd like to ask you some more questions related to these prints?

I have attached some images of the virtual model and the 3D prints here: they are a small section of the scan data and magnified x20,000.

My main question is about the shape of the object - it has raised points on both sides of the flat surface. I wondered if you could explain how these objects relate to the original scan data and the AFM process? As you can see from the images, the shape is very unusual. Could you possibly explain how the AFM has created this model?

If you prefer, I can meet you with an example of the 3D print - so you can see it in person - although I do understand you're very busy.

I look forward to hearing from you anyway-

Thank you Genhua, in advance,
With best wishes
Katy

Katy Connor

Artist | PhD candidate in Experimental Media
www.katyconnor.com

Spike Island Studios, Bristol
http://www.spikeisland.org.uk/people/detail/katy-connor/

---------- Forwarded message ----------
From: **(pg) Katy Connor** [redacted]
Date: Fri, Mar 11, 2011 at 11:28 AM
Subject: AFM Scan imagery
Cc: [redacted]

Dear Genhua,

I am writing as I took part in an AFM workshop in July 2010 with iDAT - and with your help - we made some data/images from using the microscope.

I have since made some art work from the scan images - some prints [200mm x 200mm] and laser engraved floor tiles [1200mm x 1200mm].

I would now like to establish the real scale of these works - ie the order of magnitude - from the scan image upwards?

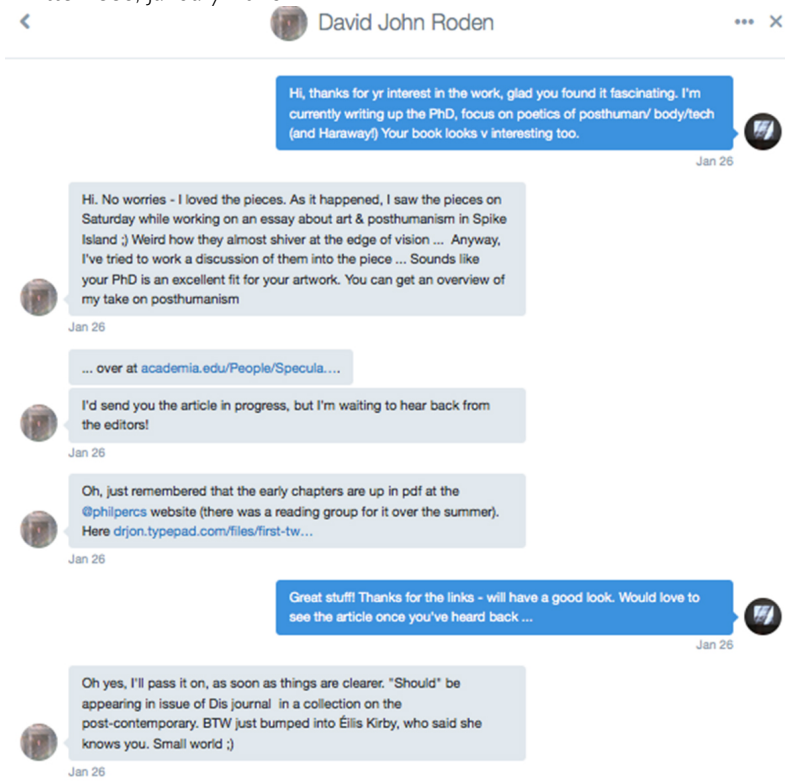
Could you please let me know the actual size of the original material that was placed under the probe/AFMicroscope? How big the area was that was scanned?
Then I can attempt to create a scale for the image, ie . 1 x 10-3 :1

Some more images of the work can also be found at http://www.katyconnor.com/current.html

I look forward to hearing from you soon,

Appendix 14: Correspondence with David Roden January 2016

Twitter feed, January 2016



Twitter messages January 2016

"I loved the pieces. As it happened, I saw the pieces on Saturday while working on an essay about art & posthumanism in Spike Island ;) Wierd how they almost shiver at the edge of vision ..."

David Roden
correspondence via Twitter (2016)

"These digital solids seem to withdraw from the viewer, as if reserving a secret that can never be made visible. As Connor writes: "The image flickers between representation and digital surface; its media inseparable from its subject, rendering it hard to decipher." [1] Along with Creed and Nolan and Morton they do not simply conceptualise the volatility of existence under conditions of extreme modernity, but harness it in order to better understand it.

The mountain stumbles somewhere; a huge sound rolls off our silence. We cannot name it."

David Roden
extract from *Getting Over Ourselves: From Zero to Hyper-Modernity* (forthcoming, 2016)

[1] See artist's website: http://www.katyconnor.com/NEW_Untitled_Force.html

Appendix 15: Peer Critique [Full Transcript]

Zero Landscape exhibition - Test Space Spike Island, Bristol Friday 5 February 2016

Katy -
Thank you all for coming. So, I'd like to get a bit of feedback, to get your perspectives, on what you thought perhaps the work was about? What you were interested in? Or if you had any questions about the work that you wanted to ask that hadn't been addressed - a few of you came to the talk last week… I don't know if anybody's read the sheet?

Sophie -
Yes - I was quite interested in the first initial question that you have on the sheet - *is the body our individual point zero: a position which we inhabit and from which we survey our surroundings?*
And I guess that made me think about the nature of *encounter,* and ways of being with the world, and of thinking of interior and exterior-*scapes.*
So that made me think about different modes of being with the world - like the world *for* us, which is like, we're at the centre of the world or the world not for us - which at least makes me think about the void, or something beyond or unknown? Which perhaps conventionally as being the sea, as a sort of place of horror, in films and things like that, the unknown - and perhaps *space* as well?

K - Yes - an alien kind of encounter?

Sophie -
Yes. And then the world of itself - so basically, we have access to its plenitude. So I was just thinking about those sort of ways of being with the world - and I was quite interested in the world not for us - perhaps because it made me think about the sea - and that place of horror and unknown - and how more recently it's been 3D mapped by, I think it's the Mariana trench is being mapped by James Cameron and Google have been mapping the sea bed - and so that's changed our relationship with the sea, so it's no longer a space not for us, or a space apart - so what is it? What is our relationship with it now? Now that it's been 3D mapped?

So - it's kind of a lateral take, this - but I was thinking about the watery conjunction between us and the sea, and again thinking about the relationship between interior and exterior *scapes* within your work, I felt that there was a real sense of *mutuality?*

And this is the really lateral bit - which is the jellyfish and its relationship to the sea - but because it's made up of 99% water the only way it can differentiate itself from the sea is through movement - and so it's totally co-joined with the sea and is a site of *mutuality.*

And I just thought that was something that was characterised the relationship in your work between the interior and the exterior scapes, so - just as a sort of thought.

And also the disk of acrylic, being also that kind of motif - being a bit like, the world as well, but it's kind of reflective, and it could also be a world contained model - not model, but contained 3D rendering just as well, as just changed orientation of something ... thinking about that as well...

- slight interruption - member of public wanders in -

K -
Yes, from what you were just saying, I'm really interested in that threshold space between the interior and the exterior - and the sea is often a symbol for the liminal isn't it? And this in-between space, or a kind of void space, crossing the threshold - and that's a significant aspect of the questions in the PhD - this kind of space *between* the body and the technological really, and how they mesh...

Sophie - like the movement between them? ... almost like the digital and the analogue it seems like?

K -
Yes and the natural and the technological and where, how they cross and fuse ... There is this element of time, as it's moment to moment, it's not fixed as a kind of 'this is one' and then, 'the other' : it really changes in a dynamic way, in different situations, and it's also a site where it can be

very politicised, where the borders really come down, especially with regard to a lot of - where instrumental, synthetic engineering paradigms meet biology for example; genes - there's a lot of politics around that area.

Colin - These images, are these made by..? These are micro - are these things we can't normally see? How are the images made?

K -
Yes, they're made by.. The original image there [gestures] which is the framed image, is a scan; it's an Atomic Force Microscope scan. And it produces a 2D image file - which you see there - but it also produces a kind of topographical landscape; and this functions in a similar way to LiDAR, or the way that the ocean bed is mapped, I think it's a similar kind of graphic, once you see it in a CAD programme, a kind of virtual model, software modelling programme.

So what I've done here - these [gesturing to the large billboard] are views into that same model, but framed by the screen. And what I found... I wanted to *render* that in some way. You can quite easily print that as a 2D image but when it comes to rendering as a 3D object, what I found was that it was really difficult - and that prompted a lot of conversations, and thinking about - *what is this?*

We're prompted to think that anything virtual can be made into a material object, especially through 3D print - it's supposed to be this magic - it's framed as this magic process -

Richard - Yes - it's very much been sold like that, hasn't it?

K -
Yes it has - completely - so I was really interested, and thought well why can't it render *this*? which is a microscopic thing? and it turned into this series of realisations... Well, there's actually 2 million facets, which are these kind of triangular aspects, so that started to prompt a lot of conversations about *what this is.*

So I was only able to render certain aspects - the two prints here [gesture to sculptures] I did 6 all together, and these are two of them and I showed one of them at the Control Room space.

Jo -
Going on from that, I really enjoyed the 3D prints and their relationship with the kind of larger 2D prints - but I've been thinking about this quite a lot - because I find the original technology for taking that original source data really fascinating - because it's that *beyond visual* - you know we can't - that's the first time that we could see that [gesture] because it's so microscopic - it's invisible to us - like most molecular structures and things like that.

But how it's really interesting, is that even though you've got the *data* for something that's so tiny, you've had to make it *even smaller*, to produce these actual 3D pieces. Do you see what I mean? It's cut down again. You've got the smallest - the view point from the most micro, nanoscale, and then from that you couldn't even replicate *that*, you've had to just take a tiny percentage of that little bit, to start digesting the information.

K - Yes - and also then you start to think, well if I *could* replicate it - then how big would it have to be? and then you get into this crazy world of scale - what exists virtually can't actually be replicated in the real world.

Sophie - You're kind of bound by the machine aren't you - in terms of what you can print...?

K -
Yes, and also the physics of it - I was working with these engineers at Exeter University and put in this request, and they went silent for about 11-12 weeks, and then sent me this email saying "um sorry, we can't really do it". I thought it was just a really funny way to start the conversation!

So I went and met them, to talk to them about it and I think at the time, they were like '*what even is this?*' So we started by trying to print the whole thing, and then tried to grid it, to print it in sections,
What happened was the laser - because it's made with a bed of nylon powder and it's heated up by a laser, that melts certain bits of the bed -

but what was happening, because it was so intricate, the laser was melting the bits that it had already printed so it just fell apart.
So then we started to think, if we scaled up certain sections of *the map* - that's how I started to think about it, as a kind of *Google Maps* - ok, if we enlarge this bit, then what would that look like? So in the end, I've got these six or so kind of sections, some of which are rendered better than others, some - well they're all at different scales; so it's quite *a peculiar geography.*

Solveig -
I find that the most baffling thing to try to imagine, the scale at which this is at. So you've made a visual of something, which is inherent to us, but I find it absolutely impossible to relate to it. And the only way I can relate to it is in '*Arctic landscape*' or in *imagined internal landscapes*, and those two things together, and the insides and the outsides.
And in a way they work really well because our, for us who haven't been to the Arctic, it's probably as foreign from the reality.

Richard -
I think the link between the sculptures and the blood is really interesting, how - you spoke it your talk - about Nylon 12, it's what your sculptures are actually made from and its presence in cosmetics and suntan lotions and all of these things, so it can quite literally become part of your body, part of your blood - you'd apply it, and have it absorbed through your skin. It's made from oil isn't it? A substrate in some description, so again there, you're literally bathing in oil to protect yourself - or increase your health, but also how that breaches the boundary point of your body as well - and it can come all the way through and I must admit I'd never thought of cosmetics or suntan lotion like that.

It made me really reflect on that. You're looking at a solid object and then thinking, well how would I actually absorb *that* through my skin? And you do that really casually without thinking about it and I found that, yes *that* was a really interesting threshold.

K -
Yes - I was quite horrified when I researched into Nylon 12 - it's [content is] up to 35% which is quite a substantial amount, especially anti-ageing creams, but it runs through all cosmetics, suntan lotions and face powders, so can be inhaled as well, potentially - which is quite alarming really.

Sophie - it's like a breach isn't it? Of the body and the interior ..?

K -
Yes. And we're used to thinking of plastic as pollutants - you know as bottles being thrown away and washed up on the shores, and starting to think about micro plastics, the little beads that are in toiletries, but not the fact that plastics make up so much of the things that we use everyday and *that* being a pollutant, but on a much smaller scale...

Solveig - And that they're being assembled in similar patterns to that [gesture to 3D print] but *naturally* -

[lights go out - dramatic] [laughter]

Éilis -
In this space it's that image there that really grabs me [gestures to the large print] - at first I'm not sure if I'm being - my stomach lurches - I don't know whether I'm being sucked in or spat out - and I don't know, I kept thinking of *Bladerunner* but I don't think it's in any way relevant but then I start thinking of other science fiction films - and wormholes and black holes and then, as we're talking it's *Fantastic Voyage* - you know that 1970's film where people are shrunk down to tiny tiny molecular size and they travel around the blood stream - do you know that? and I thought "yes! that's what it is!!"

[much laughter] ... and they drive around the blood vessels...
It was interesting though, when you were talking about all that threshold stuff - sorry that I have to bring it down! - and I was sitting here thinking, like I said, 'I'm not sure whether I'm being sucked in or spat out' - and of course there's *The Matrix* happening over there [gestures] it just seems almost like it's come out of nowhere, because there's this *scape* or this wormhole thing - and then suddenly there's *The Matrix* - it's interesting all these films ...

Colin - Yes I was interested in that bit of the image [gestures] - where that image comes from - how come *that* is clear?

K - The triangulation, tessellation bit? Yes, I'm not entirely sure -

Sophie - Isn't that part of scanning? The very rudimentary part of scanning...?

K -
Yes, well all of the models - when you look at it in the virtual 3D programme - that's exactly what they're made up from, it's called tessellation, the triangles [STL Standard Tesselation Language]. But those [gesturing] are quite equilateral, they're quite regular - and that's how the shapes are modelled -
with the elements of the print on the rear side - these kind of spike features - they are still made up of these triangles but they're really elongated - so I think the reason that you can't see the triangulation in areas such as this [gestures] is that they're minute *on the screen*, and then once it's become printed you don't see them at all.

Éilis - You can see them though, the triangles you *can* see them, but I just hadn't noticed before you said that.

Stephen -
This bit that you described as *The Matrix* - I was reading yesterday a book called *Protocol,* by Alex Galloway which is about the architecture of networks and how it affects society, and *this* [gestures] is exactly the pattern of a Distributed Network, which is how people typify the internet as a decentralised system of interaction and that is exactly how it's drawn, and I never even realised that before today. So in a sense, that looks like a diagram of the net.

Colin - Yes!

K - Hmmm, so what's this ? [gesturing to the rest of the print]

All - Interference! [laughter]

Sophie - this looks a little bit like the noise - that you used to get on the analogue TV, when you'd get no transmission signal -

Éilis - Yes microwaves, isn't it?

Jo - remains of the Big Bang, which is *cool*

Colin - When you came - I mean, these two images [gesturing to billboard sized print] did you make choices about them?

K - They're all one image,

Colin - Just one big image - so one big section?

K -
Yes ... it's a view of it, a kind of view of this world on the screen, it's a screen *grab* really - and then I made a few and then printed them out, and then risographed - they went through a risographic process - still as quite small to make them more *dots* rather than pixels - and then I rescanned them and started to explore scale -

Éilis - So you went from digital to riso to digital?

K -
Yes and this is the biggest that one of them has grown - and this is made through the same process as you would make a billboard print - so the dimensions are the same as the largest billboard 'screens'

But there is a correlation - you can see a small section on the - I keep wanting to call it a satellite map! - But on the original scan, there's like a small little island, which is the same island as this land mass here [gestures] and also *this* area here [gesture] you can see is an area rendered in the 3D print - so there is a kind of relation between those three.

And then the kind of *extreme spiky one* - I need to give them names! [laughter] is from much further down …

E-
I see that as the holy one, as it's got holes in it [laughter] that one hasn't. And if you look from this side it's like constellations - because of the black and white behind - you move your head (I was having fun!) you move your head and you get the dots flashing, up and down, I thought it was exciting...

Jo -
Yes, I think something else that's really interesting, just talking about that island being relating to this [gestures] - and you know we're making lots of topographical and map-related adjectives to describe it because it is so... I guess that it's the way that we *discover*, or process new information, by going from a very simple structure ...

So if we didn't know what that land over the sea looked like originally, we'd go over there and we'd make a map of it and therefore we'd claim it in some way, and therefore we could process it - so we're sort of doing the same thing with this information that we can't necessarily visualise - visualise in the sense that we can't physically see it until we start putting it through so many processes.

But when you told me originally that *that* was that one [gesturing to the print] - I was like, 'But it's the other way round!' And it made me think about orientation and when you have a map you normally have some sort of guide that stabilises the information, so when you're looking at a normal map, you're like ok - well, there's North, and therefore you can process it -

- and with this information, I remember first thinking well, why isn't there just like a whole representation of that original source material - because you've just chosen certain ones ... and then, I thought well *actually* it's quite interesting that they're all rectangular - therefore they're all through mediatised ways of looking at stuff -

So normally when we process information now we're looking at it through screens or through advertisements, like billboard posters so it's now fitting to a more modern way of how we look or visualise information -

But the thing that's kind of curious is that there is no orientation on these images - if that makes sense? We understand where they're from, because we can conceptualise how that process is - or we can imagine how that process has come back. But that map could have been a total different image if it was a different part of your blood that got scanned - and then it becomes *even larger* in its scale of unknowns...

Solveig -
There's no orientation, and no scale as well. But it would never mean anything - you know when you see those bacterial images, like 1micron is this much [gestures] you have no - but that instantly makes that a scientific image, whereas this allows you to use your imagination and it completely blasts it out (?) which is very interesting.

Sophie -
It's quite interesting that idea of seizing land - claiming it and seizing land. You know, we're all seizing land all the time, wherever possible. You know like seizing bits of bank, you know close to their house, part of their garden, you know we can't stop ourselves from seizing land. It's quite interesting thinking about this in relation to the body - sort of claiming our own body, seizing the body, *at scale* which is what you're doing.

Jo -
Yes - and also acknowledging *unknowns* in the body - like, it's very - this is a bit of a leap in a way but - it's always very interesting to think if you've hurt yourself, you can process that really easily, but if you're dealing with grief or something like that - it's not something that you can necessarily see or know how to cure so instantaneously, so the kind of unknowns of things that do chemically still affect your body still having a greater affect on you than things that physically affect your body, and that relationship with processing...

We *depend* on imagination to process unknowns - so much of societal structures and how we navigate through the world is based on a belief of systems that don't actually exist - they're completely in our consciousness, so it's a very unique thing for humankind to be able to navigate that many different things that we just take as granted, so we

can get through our individual lives, how we decide to process them. But that idea of trying to pinpoint the unknown, to try to explore, it almost opens up a box where you're just like 'oh! no there's even more things that we don't know, that we don't understand or can't process' -

Sophie - The narration, that generation is quite interesting in relation to the knowns, because of the way it's kind of grappling with them, I don't know, there's perhaps a scenario here...?

[brief interruption as mop leaves - 27 mins]

K -
Yes in a way, the black circle... Yes I'm really interested in the edges of the known - and especially how you were saying about Google and James Cameron wanting to claim the known spaces of the ocean floor - I think it's really important to restate the unknown - you know, the mysterious. It has a very kind of *poetic quality* this; that should be kind of more substantial in a way, to challenge this instrumental desire to make everything mapped out, more certain I think. So that's kind of - I guess I wanted to bring that in somehow with the disc.

But also it's a kind of a relation between the 2D and the 3 Dimensional - so it's both a surface and an object.

And it's also a kind of screen - now we're used to black shiny opaque screens that then light up at certain moments. So I'm interested in that, as a kind of metaphor space. Opacity as well, is an interesting metaphor. Yes - just things that have arisen, in thinking about objects...

Sophie -
It's a void isn't it? It's a void, but also like formally it frames, as you walk into the space, it frames the different elements - sort of conflates them on its surface - so it's interesting how that operates like that. It has an autonomy, but it also performs -

K - Yes, and it's a different shape to, like you were saying the rectangular-

S - It's like *unto itself*, isn't it?

Colin - How was that object made?

K - It's a *found object*!

Colin - That's a *found object*?

Sophie - That's a good find! [laughter]

K - Yes! It's good isn't it! [laughter and hubbub]

K - Yes, it was a table top at one point... I don't know how much of that I should divulge?

Colin -
See, I was quite confused when I first saw it - I couldn't work out its relationship to anything. And it's the only bit that really has a clear colour, it has a red sheen. It made me very aware of this as being black and white. So it stood out for me

Éilis - You see red in it?

C - It has a red sheen.

Éilis - You know that internet thing about the dress? I don't see red.

Jo -
But I also found that an anomaly in regards to the rest of the work … I was thinking more about reflection than anything else. And in the same way that you have the top of the plinths, they... *that*'s an incredibly satisfying aesthetic.
But I did, I was a bit sort of like 'it's round! everything else is square!'

Sophie - But that's a different spatial logic, so perhaps that's a point of urgence or resistance - and puts into play the other formal qualities...

Jo - Yes - Well it's definitely a symbol for a void. The void. I mean you don't have a square void. It's definitely a hole.
I haven't read any of your text - by the way.

K - That's interesting, I wondered whether people do read texts?

Jo - I might do afterwards, I don't like reading texts before.

Colin - I tend to read afterwards.

K - I wanted to write something that would be open rather than explain what I think the work is about. I wanted it to be a more *open* reading of the work and what it *could* be or could refer to...

Sophie -
The piece where you had the two TV screens, in the Control Room, I thought that the one screen, it was almost like it had some sort of phenomenological occurrence going on - which looked like it was scanning a part of the body, or scanning something phenomenological, clouds passing - so I thought that there was a very strong sense of the body in relation to an exterior-scape or landscape.

And then the screen next to it - I felt like I kind of understood that as laying down a layer of nylon - but it almost felt like it was creating this virgin territory? You know, like a clean beach?

But there was these relationships to the body and these exterior-scapes were particularly resonant and strong - with that piece in relation to the other two - the laser print and the video projection.

Which I did also manage to see from across the other side of the road and a bus went by and the windows were at just the right place so I could see across to that projection!
[laughter]

K -
Yes - the two monitors in the Control Room; one was documentation of *that* print being made [gestures] - well part of it as it took like 16 hours, but it's this kind very faint line that you can read by the laser and then this sweep of the arm over the bed of powder.
And the other is satellite imaging, that is over the Antarctic - but I really like it because the movement of the ice is very biological - it's like an interior - and it's got the eye of the ultrasound - which again has a different kind of framing actually -

Sophie - Yes, it's like a segment...

Éilis - Can I ask about the models? - I'm desperate to touch them. What do they feel like? Are they fragile? Are they tough? Are they sharp?

K - Um. A bit of everything, they're actually quite strong, 'cos they're this nylon, so they're quite tough, but the points can get damaged quite easily.

Éilis -
Because I find it very hard to look at them without - I want to kind of [swipes gesture] Not only to do that - but to the sharp bits also - yes Like when you get icicles hanging off things, and you want to kick them off ... [laughter]

Éilis -
Yes I was in here yesterday, on my own ... and I thought 'don't do it, 'don't do it' - it was that angel and devil thing going on -

Jo -
But that brings up an interesting point that it's still, you know even though 3D printing's talked about a lot - it's still not a material that we have that much relationship with? It's - we don't have any muscle memory towards it or anything - so we don't really know how it is -

Éilis - Yes -

Jo -
You know? Is it going to snap, is it going bend?
And that's why it seems really appropriate to use it for this project, because of - this artwork - it's talking about an unknown as well -

Éilis -
I kept thinking will it snap? Or of toys I had when I was a child - we had around with my brothers - maybe train sets? But anyway, you know that

very thin plastic - I kept thinking, if I push it over like those - it'll be fine! It's that visceral element, you know that was obsessing me, am I being sucked in, or spat out, and then wanting to interfere with your models.

I also wondered with both of them, the height they're at - was that a very specific choice or it's a pragmatic decision?

K -
It was more kind of accident? Because those were the two plinths that I was able to get - but it was deliberate in terms of which went where, because I think the shorter one offers 'a looking down on' - so you get a different perspective.

Éilis
With both I had the desire - I was really curious - what would it look like to be further down - so I would be peering into it? And that one - what would it be like to look up at it?

Jo- Yes, they're definitely objects that you can't see quickly - you can't intake what they're like - you have to spend a lot of time doing - you know, moving around them.

Éilis -Yes, I kept thinking of icing --

K - really?

Éilis -
Yes - I think it was my mind asking questions - all these weird things came to mind - toys and cake and I think it was just that thing you were saying - trying to find a way of making sense of it - I guess my brain was making use of things that it already knew - which is why all the films I guess, came up ..?

Sophie -
But it's quite an inaesthetic material isn't it, Nylon? in a way, and its colour or lack of colour, It's interesting because the prints have a very strong materiality - so it's interesting that the 3D prints are quite aesthetic; that the materiality comes through the form - the actual materiality of the nylon - well it is what it is. But it is kind of a lesser material - immaterial... You can print in different colours can't you, like black and white?

K - Yes, I think you can now.

Sophie - I'm just wondering did you have a lot of choice?

K - I didn't really with these, no.

Jo - But you can print in different materials can't you.

K -
Yes you can, and certainly in the last few years - because of the first of these was made in 2012 - so in the last few years it's grown in terms of availability but also the materials that have developed.

But then we say '3D Print' but it's actually an enormously broad spectrum of different machinery and different purposes and different materials - it's enormous, actually.

Richard - Have you looked at the *Additivist Manifesto*?

K - Yes I have, actually... I'm a bit undecided about it.

Richard - Yes, me too.

K - Yes it's a guy, Daniel Rourke, who's a Goldsmith's graduate. It's very *nihilist.* He's developed it with another artist [Morehshin Allahyari]. They've developed this manifesto which is their take on *Additivism* - they're talking about it at *Transmediale* at the moment. But it's really quite a nihilist approach, and *delighting* in that nihilism - which I have a bit of an issue with. But also, it's claiming the territory really.

R - Yes, it is very much trying to do that,

E - Claim territory of what?

K - Of a response to 3D printing that is a critical response. But it's doing it in a way that 'this is the only response' - it's bound up with *Accelerationism* - and I have a few issues with that ...

R - Well, especially the *Accelerationism*, it's quite grim really - it's not really a useful tool for thought - a lot of noise around it in the last couple of years -

K -
Yes, I think it's more of a posture, and a position and it's quite totalising - like a grand narrative and I'm not... I'm really quite undecided about it. I think they're going to come and do a talk at Spike actually, you know the artist in residence, Tamarin [Norwood] - she's invited them to do a talk - which will be kind of interesting I think. It'll be interesting to hear what they say, but it's - to me it just seems like slogans. They're saying about the petrochemical content of plastics, but it's really quite banal ...

Richard -
Yes, there's interesting element, but how they bring it all together, it's not... Yes, and it is too overarching as well, isn't it?
Which segues quite nicely into a point that I wanted to make -

When I first looked at this [gestures to large print], I was frustrated that I couldn't stand off, you know - and make the image *change* and, as I thought about it more and then, when I read your text here, you reference that very directly - because that's *really* interesting, because it *forces* me to completely change my relationship to it, and my own desire to be able to stand further off and have my own [relationship with] the image just as you would with the smaller print - how much it changes and your own desire - well *my* own desire - for that kind of totalising experience - it's really interesting how you decided to install it, and reference that -

K - So you don't get that ability to stand back and take it all in?
R - Yes -

Stephen - But that's kind of ownership isn't it? That's like - you know - ocular possession of a picture: I can stand there and I can have this perfect fixed viewpoint of the painting and it is *mine* - and someone else can't stand there because I'm stood there -

Richard - I've got the Cardinal point -

S - exactly -

R - It was really interesting to be confronted with my own desire for that -

K - a lot of people have said that they wanted to be able to stand back from it actually, but it was intentional -

Sophie - You experience it more, as you're walking. Well, I come through the space a lot, you're in close proximity to it - it resists your ability ... at a distance.

R - Yes - and I really like that really enormous magnification that retains its opacity and through its opacity it becomes something else entirely. It actually gives you more freedom through its opacity, to interpret it in different ways, doesn't it?

Solveig -
It works really well as a spatial metaphor for just being completely overwhelmed by data and trying to make sense of it - and like Jo says, we read it as a landscape, and having these very shiny black surfaces that it's mirrored in - really takes me to icebergs instantly and gives me that really nice leap.
And all the spaces in between these are very interesting. I've been thinking a lot about dark matter recently, so 85% of the universe we have no idea what it is - but it is the reason that everything comes together and we have no ways of perceiving it, so all those kind of all important vital spaces in between things that we just have no way of perceiving. You know we don't know what it is but we have based our physics on it - quantum physics.

K - Is that like neutrinos as well, that pass through everything?

Solveig -
Exactly - it doesn't relate to any ordinary matter and it's so vital to our existence and thinking about that [gestures to one of the 3D prints] and how that's constructed and all the spaces around that and what facilitates it and what made it grow, it's interesting.

K -
One of the uses in industry of the AFM is to miniaturise hard drives, so it feeds into how hard drives in smartphones are able to be mobile, and how computers get smaller and smaller through the use of that technology - which is interesting...

Sophie - Have any of the scientists, the technicians that you've worked with, have they come to the exhibition?

K - No actually,

Sophie - I'm just wondering what they would think about you know, the implications for the 3D prints...?

K - It's quite interesting actually, just actually being in a lab where it's a very different paradigm - it's all about the achievement of the object - making sure that it's true to form in a way.

Solveig -
How do you feel about the visual versus the knowledge aspect of it? How much of it is wanting to know? And how much is wanting to visualise it and how do they feed into each other?

K - Do you mean through the PhD?

Solveig - Yes, and in your research, and in creating these objects from this knowledge? How -

K - How do they come together?

S - Yes, do you think you know more about the data now, or ...?

K - I don't know any more about the original data that came from the scan but I feel I know a lot more about the process of rendering - of 3D print.

But in terms of what led the other, it really was a to and fro process - of being really interested in the scan originally as an image - the way that it models and references landscape - and thinking about that as a metaphor for interiority I suppose.

And then, starting to develop the work through the 3D printing - and then processes of reflection on the work, how it's is perceived in the public eye, and how it's carried out in labs in university environments, and then these discussions about whether it's going to change - you know because everybody's hyping it as changing the world - you know that everything's going to be 3D printed and it's going to revolutionise how we, you know, deal with the world, and ....

And then making more of the models, and finding out about the materials, it's really a back and forth process - finding out - and it was really serendipitous in a way. You know, I was interested in the way that these models kind of capture things inside the body - or at least that could be metaphors for these things -

And then I found out about the actual materials they were made from, after the fact. You know, it wasn't a deliberate decision to make them from Nylon 12 - but it's the material that these were made from and most 3D Prints are made from, certainly in *this* lab anyway.

So it's really a process of crystallisation in a way - with all these different elements coming in - does that make sense?

S - Yes, absolutely

K -
I'm really interested in the PhD process, as I reach the end of it - how much all of these different processes and ways of thinking come together in the work, and how it's received, talking about what it might mean - how it all comes together as a body of research is really interesting.

And it's not - it's not an instrumental or a clear cut process actually - but it's convoluted in the way that a lot of art making is convoluted, you can't necessarily - you, you follow an intuitive *hunch*, don't you? and then you find out afterwards, 'ah, yes, that totally relates to that, and I had no idea!'

Solveig -
Do you find you're kind of pushing that mystery in front of you, in a sense? To keep it mysterious and to keep it interesting ? So you're holding back from fully understanding it, in a way? Because I think I would in this case. as I wouldn't want to get into the maths of it and ruin the mystery for myself - I want to be able to visualise it as this kind of - to have that *space*, which I think this does really well because you're not, you're not like we said, using scale or a direction, so you have that space.

K - Yes - I mean I don't - I wouldn't pretend to try and understand it mathematically --
Jo - That would be like *another* PhD! [laughter]

K - But taking it from a lab context into an art context, is really - it just allows for much more freedom with it.

Solveig - Have you asked the scientists who are helping you to see it as an artwork, from your perspective? Or tried to get them to see it from an artists point of view? As a composition or as an aesthetic ...

K - No I haven't actually!

S - That might be quite interesting? To try to wrench the science out of their head for a bit?

Steve - But you did ask them to think about how you'd approached 3D print differently, to all of their clients...

K - Yes - that's true, I did! I recorded an interview with the main engineer who I worked with at Exeter, and he was quite baffled by the whole process, I think it's fair to say! [laughter] He did say something like, 'yes your work has tested the limits of the machinery', and this is really, high-end -

Solveig -
That's really fun isn't it? I ring people up and ask them about filters, and stuff - and they say 'O what are you going to use them for?' and I explain it to them and they don't understand - they have no way of understanding this: 'What process is this?' you know? 'What standard lamp process is this?' and you're like 'No, it's just something I made up' - 'Why are you doing it?' - 'Well, I just want to try it.' It's not an institutionalised knowledge research-based thing - like you say you're going on a bit of a *whim* - chasing after that next interesting point that you want to make...

K - Hmmm. Yes - But sometimes it comes to a point where there's a kind of *Damage Limitation* - 'It's an art project' or 'I'm a student, go with it' - you know?
[laughter]

Colin - So where did this get made? [pointing to the AFM scan]

K - That was made at Plymouth University, in the lab there. They have this big, well it's an Atomic Force Microscope -

Colin - And what are they normally making? What images -

K - That s where they do, its called *Spintronics* - which I think is a *brilliant* name!! [laughter]

Colin - Spintronics! Sounds like an exercise!

Éilis - Spirographs! Its Fantastic Voyage! It's the seventies all over again!

K - Yes, I just think of break dancing!!
But, no it's where they're researching into the miniaturisation of hard drives .. so that's the kind of research - to fit more information onto smaller ...

Colin - So that's what *they're* using it for?

K - Yes, but it's also used for some experiments in biology ...

I think it was developed in 1987 as a tool ... then there's the Scanning Tunnel Microscopes, that are slightly different, that work in kind of similar ways - where you're imaging things that can't actually be seen, it's not about that kind of lens, that's bringing things up, so that we could actually see - We're working below the threshold of sight - which is where it gets into that area of waves and particles ... and all of that *stuff*...

Sophie -
When you were talking about your process of discovery and working, I was just wondering about whether there was an *Inventory of matter* - where your blood, try to narrow it down and it being translated into nylon and paper. I don't know, just thinking of tracing -

I think because you were talking about, I was just thinking of that structured writing *into* the work you know, how nylon has been used as a physical cosmetic and creams and oils ..... and I was just thinking about ... Is it interesting to write them into the work itself? Or if that's something that's written about externally to the work, if it's written in the literature...?

K -
But it is interesting isn't it, when you go to some installations, that the artists list what the materials are - there's something quite concrete to naming the different elements of an installation. Yes, interesting to think about the different - But then would you list the computer as part of that? Because what on earth are the elements - ?

Stephen -
But it's also then an inventory of processes for you, isn't it? Not only an inventory of materials - it's like there are so many different *hows* - you know - this is an Atomic Force Microscope *scan*, then printed by a giclée *printer*. Then this is a *screen grab* turned into a *risograph*, scanned back and turned into a *billboard*, you know? And in a way that's more important than ink and paper....?

Solveig - Where do you want to take it from here? What's your next - what would you like to do with this, going forward? Would you like to keep developing this? Or...

K -
Ummm.. I'm not entirely sure? I'd like to - yes I don't know, because it's been quite along process - it's been like 4 years or something, so in a way, I'd quite like to park it? But at the same time I feel that I'm only starting to just push it into the public, into the open? So...
I spoke to somebody the other day who said she wanted to see more of these [gestures to billboard print], or wanted to be in a space where there were more of the large-scale prints - with the works.
I suppose I'd like to re-present it, in *other* spaces?

Richard -
It would be interesting to see the affects, of having the work all around you - So that, you know... but still *tight,* like they are here. So you're still-

K - So you still can't actually step back?

Richard - Yes, so you're surrounded - you're completely surrounded by *endless* detail...

Solveig - This might be completely unrealistic but I'd really like to see that [gestures to 3D print] on a larger scale and *flat* so it would be even more like a kind of landscape. And with all the ins and outs, so that the flat surface would be level - and suspended somehow...

K - Oh I see - so rather than on a plinth?

S - Yes
Éilis - Which, the model you mean?
S - Yes.

E - For a minute I thought you meant this [billboard] and laid out on the floor? Actually it would be really interesting to walk on that? Because every time I look at it, I can feel this wrenching...

S - Oh yeah! So you're more in it?

E - You'd probably have people getting sea sick, or something -

K - I thought it would be quite nice to have some kind of mirror? [gesture to floor] Or maybe again, possibly the Perspex..?
But I don't know if you could walk on that?

S - A complete room, postered in *these,* with these hovering forms...

Jo - And a disclaimer before you go in -

E - And a sick bag -

K - And a strobe. [laughter]

Richard - Just out of interest - what did you do with the blood sample, which the work came from?

K - I've still got it somewhere.

Richard - Yeah I was just interested, in whether you kept it?

Jo - It might be really interesting to have that exhibited? I don't know if you ever thought of exhibiting that? 'Cos that's like the starting, starting point?

Sophie -
I think that's why I mentioned the *Inventory* ... I was kind of like thinking actually the blood, in relation to the print - is that the really interesting relationship between the interior ... exterior scape, you know like a landscape, so I think that's where the *Inventory* comes from -

Jo - Yeah yeah -

Éilis -
Yes I think that's a really good idea, because - [pause] There's a certain coldness about it all. And I kind of got over that when you were talking about it at the talk (and I had to leave a little bit early, just as it was getting interesting, just as you were talking about the body..)
And I couldn't put my finger on what - there was something for me that was kind of, maybe *missing*? Making that link, other than intellectually, and I think yes - even a drop of blood on a slide or something I think for me -

Solveig - Scale-wise as well.

E - It would just kind of - warm it up - more visceral...
You know you're talking about the body and the visceral - and I'm there's something... I'm getting it intellectually, now that we're talking about it.

K - Yeah yeah -

E - Because I think blood would warm it up if you know what I mean? But that micro/macro thing, which is just constantly going on as well -

K - I guess as well, it's already left the body - yes, because it's there on a slide - it's no longer part of the body, but we can relate to it.

Jo - It's a more *familiar* way of seeing something that we know is ours - that's badly structured! But you know, a slide with some blood on it - people *know* about that, they have that experience.

K - Yes, it's a bit like... You know when they take a phial of blood at the doctors'? Then, all of a sudden it's gone to the lab - and you never see it again? But for *that* moment, when they're taking it out of your body -

Jo - You should have Live blood transfusions [laughter]
Team up with ... a performance piece - Give blood!

Solveig - Grim!
At the minute, it's very much about the architecture of the data and the structure of it, so I really like it for that, and I think if you did warm it up as you say - it would be more relatable, but it would also take away from that structure.

E - Do you think? I think just the tiniest bit, you know, before you walk in?

Jo - Yes

E - Otherwise it is *just* data, I don't mean - not *just* data but it wouldn't ruin it - the kind of wondering - for me at all.

Sophie -
Well the slide, it suggests that the blood is going through a process of classification. A scientifics of *scrutiny* that's implied within it - so that might work as well?

E -
I'd still be wondering what it was. But on the other hand then there'd be a bit of my mind saying, 'but it's the blood' Oh my god it's amazing - but then I'd go back to wondering what it was.

Sophie -
But the blood can have an indeterminate relationship - it's in relation to the other elements, isn't it? It doesn't need to be, like 'this was the starting point' - it's just one of the elements ... one *other* thing?

K - Exactly. And I'd really refrained from wanting -when presenting the work, I don't want it to be a kind of --

Jo - stage by stage?

K - Yes, exactly. I don't want it to be a demonstration of technical ability or you know, 'this is what we can do nowadays with this wonderful technology' - I really wanted to get away from that - but yes...

One thing I was thinking about - when I was in the Arctic there were - Every so often you'd get these *markers* in the landscape, which because it was so kind of barren, and very kind of blue-white (unless it was dark) there were these *markers* at different points which were painted in a particular kind of fluorescent red, which were quite *amazing* - I was really rather taken with them.

And I was wondering whether to introduce something like that in ... yes, I don't know - But then blood becomes something else, again doesn't it? It comes back into the exhibition - but as a *marker*.

And then what form would that take? I was thinking like a large piece of Perspex - not as big as the black circle, but that could *stand* for the blood, but wouldn't *be* the blood, so then it adds another level of questioning - well why is *that* there?
So yes, this is a question that I've asked myself.

Solveig - Do you want to link it further to the Arctic and external landscape as well? Away from the body? I think there's a really nice subtlety about that.

Jo - And I think that even though you have this association with the Arctic, I don't think it's necessarily - you know like that landscape is always *that* prominent - especially in the larger visuals? It's more just like a *barren* landscape - it could be a desert or it could be *space* - it doesn't have to be -

K - Yes, I know - it's kind of inhuman ..

Jo - And I think the sculptures definitely because of their icicle *nature* definitely relate to kind of those worlds - but I don't think it needs to be- I think it's nice to keep it more ambiguous, so that people can put their own experience on?

K - Yes.

Jo -
But then the *next* exhibition?! [laughter] could take parts of this and then be exploring ...

Sophie -
Presumably with the exhibition essentially over the two different sites, I guess you've actually got quite a lot of work? You know, the video imagery? There will a body of work, essentially that you could draw on, from these, into other configurations?

K - Yes - and I wondered whether to have the video as an element in this space, on a monitor? But I decided not to. I think it works for the video as well, to have it at a different site -

Solveig - What is the video?

K - It's an excerpt from the modelling programme... of views over and through the model.

Solveig - Oh ok, like a mesh?

K - Yes - But I've taken the colour out, and heightened the contrast, and made it more 'aesthetic' - otherwise it's like purple, and it's a bit garish?

Solveig - Why do they do that?
K - I don't know

S - They've just got no visual ... That might work really well with the table - sorry [laughter] the circle - interacting with that - see it in the mirror - as a double image perhaps.

Katy - I think, I was - I'm a bit afraid that it's a bit *formal* with the plinths - I'm a bit reticent to use the plinths, but I think, it moves away from that, by the tops

Solveig They're very nice plinths [laughter] But if you could make them hover, it would be much better. …. Easy. [laughter]

End

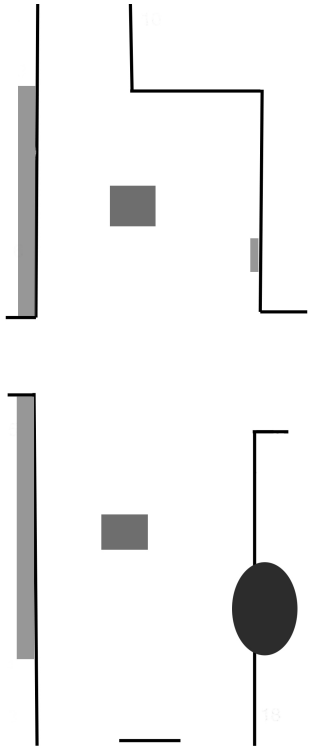
1hr 10 mins 30 secs

Thank you to Sophie Warren, Jo Lathwood, Solveig Settemsdal, Éilis Kirby, Colin Higginson, Richard Broomhall for generously giving their time, and their thoughtful contributions. Also to Stephen Cornford for the recording.

Thanks also to the unsuspecting member of the public, who wandered in and then stayed to listen for 30 minutes, before leaving.

Katy Connor | *Zero Landscape*

Test Space Spike Island
16th January - 7th February 2016



Installation

Billboard print
Fragments, Nos. 4 and 5 (laser sintered nylon)
Atomic Force micrograph of the artist's blood (giclée print)
Glass

Katy Connor | *Zero Landscape*

Zero degrees, a point of origin, departure and return. Circuit, orbit, O.

Is the body our individual point zero: a position which we inhabit and from which we survey our surroundings? Or some kind of perceptual threshold, from the interior to the exterior, transitioning through the senses; from the inwardly experienced bodily matter - the somatic - to the optic nerve, to vision ... out towards the horizon, as far as the eye can see.

With remote-sensing and visualisation technologies, this threshold elongates and expands, becoming harder to balance, to behold. Satellites and drones extend the senses outward, whilst microscopes probe nano scale particles; way beneath our perceptual thresholds of sight, of touch.

The works presented here are all derived from the same digital source: a scan of the artist's blood made with an Atomic Force Microscope. At a scale below the threshold of human sight, her body's physical substance, her bio matter recombines with machinic code and ripples out in waves of data visualisation. The objects presented here are residual forms; translated, enlarged, fragmented, elongated. Through processes of print, new landscapes are created - a Zero Landscape at the threshold of body and machine.

The sintered nylon sculptures, are rendered through processes of additive manufacture, commonly known as 3D Printing. Their fabric, Nylon 12, is heavily used in industry and is a substantial material ingredient in cosmetics. As a pollutant, these plastics invisibly weave their way through and around interior and extended geographies.

Zero Landscape also refers to an essay by Timothy Morton, *Zero Landscapes in the Time of Hyperobjects.* where he critiques the modernist idea of the landscape, *enframed* for our contemplation. Morton directs our attention to the environment - not merely as a passive backdrop, but rather the cause and driving force of massive transformation - an active agent of future evolutions.

Zero degrees Celsius is the freezing point of water. Are these Zero Landscapes then vistas, over cold icy terrain? Connor has recently returned from a remote artist residency in the high Arctic, obliquely referenced by the sheer scale of the wall print.

Witnessing the face of glaciers over 80 metres in height unsettles our concept of scale. Here in Test Space our bodies are implicated in the work - it is impossible to stand back, to get an overview; the image dwarfs us in its expanse, the landscape swallows *us*.

The exhibition takes place over two sites: Spike Island's *Test Space*, and the *Control Room* on Bristol's Harbourside. Over day and night, each turns the other inside out.

The Control Room, Bristol
18th - 25th January 2016

For more information, please see
https://bristolcitycouncilcreativespace.wordpress.com/

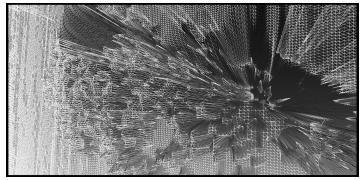


Image: Katy Connor *Zero Landscape*, 2015: HD digital mesh

Katy Connor is a contemporary media artist whose practice explores the poetic threshold between digital and physical form. Continually drawn towards the ambiguous relationship between body and machine, she investigates how our lives are mediated by technologies, in a dynamic both alienating and empowering. Connor's current work explores processes of translation, through microscopy, modeling and 3D print; prompted by images of her blood seen through an Atomic Force Microscope, which resemble satellite vistas over distant terrain.

Connor has undertaken artist residencies in science and engineering labs, and the remote Scottish Highlands. In October (2015) she travelled to the High Arctic to develop her research into imaginative, interior geographies of the body.

Recent exhibitions include *Transmediale*, Berlin (2013) the Lumen Prize New York, London and Hong Kong (2013) and CONTACT/SURFACE, Exeter (2015). Connor is a PhD candidate at the Centre for Experimental Media Research, Bournemouth University.

**Event: Thursday 21st January at 6pm.
Katy Connor in conversation with curator Ros Carter from John Hansard Gallery.**

Appendix 17: Email from Sophie Warren

Artist and Studio Holder, Spike Island
January 2016

Sophie Warren
Fri, Jan 22, 2016 at 9:54 AM
To: Katy Connor

"I'm so sorry I missed your 'in conversation' evening.
I've been a bit off radar... writing and so didn't pick up the email.
I'm kicking myself - I would loved to have come. I hope it went well. Great to have John Hansard gallery involved.

I didn't really get a chance to say much about the work in the test space when I last saw you. It's a really beautifully composed exhibition - the prints are fabulous and the scale of them in relation to the other elements works so well.

I also really enjoyed seeing your work in the control room on Redcliffe bridge - there's something so exciting about it being activated by the darkness particularly in relation to notions of interior landscapes. The extended conversation between the works over two sites has a quality of resonance - prolonging the work like sound through reflection and vibration. Congratulations Katy!

Obviously there is a lot more to say but I hope to bump into you at Spike.

So long for now
Sophie X

Sent from my iPhone"

Appendix 18: Publications

Public Exhibitions

2016 *Zero Landscape*
Spike Island Test Space and The Control Room, Bristol

2015 SURFACE /CONTACT
Exeter Phoenix Gallery, Curator Matt Burrows

2013 *3D PrintShow*: Art Exhibition
Industry & Design Conference, London, Curator Carmen Salas

2013 *Transmediale* Berlin
Exhibition and Performance, Curator Jacob Lillemose

2012 *NeoReplicants*
Exeter Phoenix Gallery, Digital Arts Commission

Published Written Works

2013 *Translating Practice.* pp. 127-133
Journal of Writing in Creative Practice, Volume 6: Number 1.
Bristol: Intellect

2012 *From Solid Light To Satellite: The Materiality Of The Moving Image As Broadcast Signal And Data.*
Brighton: *e-PERMANENT*

2012 *LIVENESS* publication: Co-Editor
Authors: Sally O'Reilly, John Hammersley et al.
Bournemouth: Experimental Media Research Imprint

Conferences

2015 *ReDefining Print*
Commissioned Artist, Double Elephant, Exeter

2013 *Generative Constraints*
Royal Holloway and Kingston Universities, London

2013 Fascinate
University College Falmouth

2013 *Critical Ways of Seeing: Visualising Knowledge in a Digital Age*
Department of Media & Communications
Goldsmiths University, London

2012 *From Solid Light To Satellite: The Materiality Of The Moving Image As Broadcast Signal And Data.*
LUX *Biennial of Moving Images*, ICA London

2012 Postgraduate Research Conference
Bournemouth University

2012 Contemporary Art & Design Research Conference
Wolverhampton University

Artistic Research Residencies

2015 *The Arctic Circle*
Art and science expedition to the High Arctic, Svalbard

2013 *OUTLANDIA* Artists Field Station, Highlands, Scotland,
London Fieldworks and Tracey Warr

Activity as a member of EMERGE
Experimental Media Research Group
Bournemouth University

2013 Coordinator: 'Art in the Expanded Field: Digital Media, Networks and Technology'

10 week series of presentations by artists, academics, curators

Weds 24th April
Curator Rob La Frenais (Arts Catalyst)

Weds 1st May
Pauline van Mourik Broekman
(Mute Publishing)

Weds 8th May
Professor Charlie Gere
(Director of Institute for Cultural Research at Lancaster University)

Weds 15th May
James Bridle

Weds 22nd May
Ilona Gaynor (artist, Co-Director, Department of NO)

Weds 12th June 2013
Rachel Baker (Irational)

Weds 26th June - (cancelled)
Artists London Fieldworks

2012 Coordinator: (with Dr. Tom Davis)
LIVENESS symposium

Co-editor: LIVENESS publication (with Dr. Tom Davis)

2012 Exposition of Research

I presented the first 12 months research practice to members of EMERGE. This took the form of an exhibition of practice, documentation of tests and prototypes and a short written introduction to the research, alongside a desk-display of some of the texts and materials that were fruitful to the research at that point.

It was an open-ended exhibition, and elicited both conversation and direct and indirect feedback from research peers and academics from BU and AUB.

EMERGE: Experimental Media Research Group
Critical dialogue, collaboration and dissemination across fields of practice

Visual Arts

Journal of Writing in Creative Practice

Volume 6 Number 1

intellect journals

ISSN 1753-5190

Journal of Writing in Creative Practice
Volume 6 Number 1
 doi: 10.1386/jwcp.6.1.127_1

KATY CONNOR
Bournemouth University

Translating Practice

Keywords
translation
action
form
idea
material
immaterial

Abstract

At Translation: Pairing Practices, London in June 2012, participants were given the following instructions:

Listen to the description of a piece of work given to you. You'll be given an instruction to fulfill an **action**; to respond to the work, as a way of trying to connect you to an experience, or a thinking process. (Tracey Warr and Bruce Gilchrist – Workshop Leaders, emphasis in original)

This text is a selection of some of the processes and outcomes generated through the workshop. Starting with an account of a conversation between Bruce Gilchrist and myself, translation occurs through voicing and sharing ideas, and develops through actions, images, words, drawings and additional reflective texts. Yet, what often inspires in such encounters are the spaces *between* the actions and words. Here the accidental happenings and collisions form and coalesce into a deeper meaning and subtle poetics.

Both artists' respective projects attempt to translate immaterial data into material form:

Bruce Gilchrist is discussing the work *NULL Object*: London Fieldworks
http://www.londonfieldworks.com/projects/null-object/index.php.

Katy Connor is discussing an ongoing project, part of her practice-based Ph.D. in Experimental Media, http://www.katyconnor.com.

The following is a transcript of the conversation between Katy Connor and Bruce Gilchrist.

Katy Connor: So the work I'm doing at the moment originates from a series of Skype conversations – do you use Skype?

Bruce Gilchrist: Yes

KC: So when you're conversing with someone, and it's really noisy and the signal's really bad, you have these crystallizations of pixels and they kind of stick and coalesce.

BG: On the screen?

KC: Yes – on the screen. So I've started to make these into material; I've started to build in graph paper some little maquettes of how these might be if they were material in space. And at the same time, I'm also working through a process of 3D printing, to produce these as objects that are printed from a CAD maquette.

So through these different processes I'm trying to create a form that could be the material substance of this mediated conversation that occurs in Skype, so I'm trying to give it shape. What I'm thinking with the project is how to make material this media.

BG: Do you want me to do something while I'm holding that amount in my brain?

KC: Task

I'm thinking that you're looking at screens in this space – but that can be quite loose in terms of being open to what a screen is. It doesn't have to be a video monitor, it's about finding something that could also be a screen in the space.

BG: That'll keep me busy (laughter).

BG: So, I'll describe something that I'm working on right now.

And again, its a combination of the material and immaterial and I'm working with something that I've been collecting for quite a few years, about twelve years or something like that. I've been collecting neurophysiological data of people, as a consequence of people perceiving depth, stereograms.

A stereogram is an image that comes out of a discipline called psychophysics – which is a way of monitoring how the brain responds to stimuli. So, in collaboration with others (and those others being robotics engineers, neurophysiologists, computer programmers and two other visual artists) we're going to use that neurophysiological data to control an industrial robot to create a void in a block of Portland stone.

At the centre of it there'll be the figure of another artist, he's quite elderly – 85 years old. He will function as a kind of neurophysiological trigger. As a consequence of him attempting to think about nothing, the robot will create a hole in a block of stone, Portland stone. So this is the kind of material that's used to make buildings of authority, government buildings.

And it will be about 75 centimetres cubed and it will be mainly hollow, carved as a response to this guy trying to think about nothing.

KC: So the data is from him …?

BG: It will be his EEG (Electroencephalography) from him as he's attempting to think about nothing, will interact with the database of EEG of people perceiving depth from stereograms. So there's a poetic aspect, in the way that his EEG interacts with the other data, and that then becomes a machine instruction for the individual robot to create space in the block of stone.

KC: So the space echoes the void, a kind of meditative, internal space?

BG: If that's what you think, that's fine.

BG: Task

What I want you to do is to leave the building and do a little survey. Stay on this block and do a little survey of different building materials. You've got ten minutes – so stick to this block and look at the building materials be aware of how that materials put together, contemporary materials, scan the buildings and do a mental survey come back and describe the piece of work that I've just described to you.

Before explaining this project and its groundwork, I need to write myself into the picture …

Bruce told me about this work in progress, collaborating with a series of scientists and computer scientists, a robotic machine to carve out of Portland stone a void that is informed by EEG data from an older artist who's meditating.

The session had a sense of doubling – as we split up into pairs around the room. There's a sense of translating current practice into words, the immediate need to make a series of ideas still

in process and unresolved, understandable now through voice, somehow coming together, now being quietly spoken to the other.

In the session I'd shared with Bruce the outline concepts of a piece of work that I too had been contemplating – how to render an immaterial object into material form using systems of drawing, computer-aided design and processes of rapid prototyping. My practice was to render a coalescent imagining into material form. It seemed like Bruce's project in reverse.

My task then, was to go outside and look at the material substances of construction; to spend time contemplating concrete and stone and the fabric of architecture. Having slipped my phone into my pocket, I captured a few photographs.
It started to rain, so I came back and started to write…

At the centre of stone:

that rock, that hard faced solid functional mass of slab,

that slab, that hard faced sheer depth of solid weight of hard heavy –

When faced with the sheer monolith of multiple edges and tough concrete forms,

the intangibility of the silence of the thought that edges onto nothing,

the meditative centre of contemplative thought,

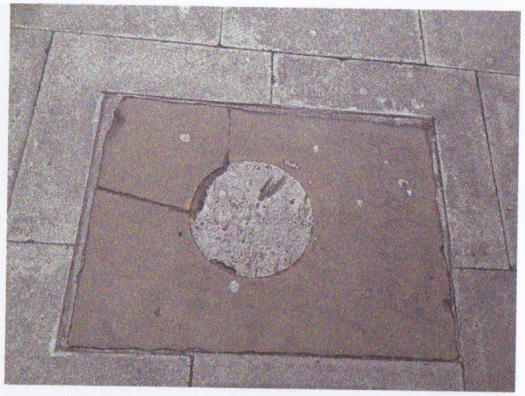
at the centre of the thought, of the void,

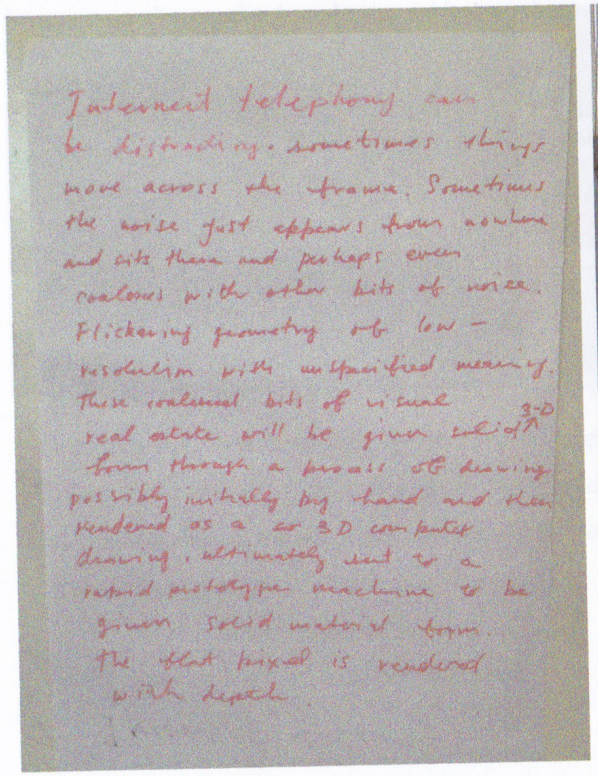
at the centre of the hard solid concrete form.

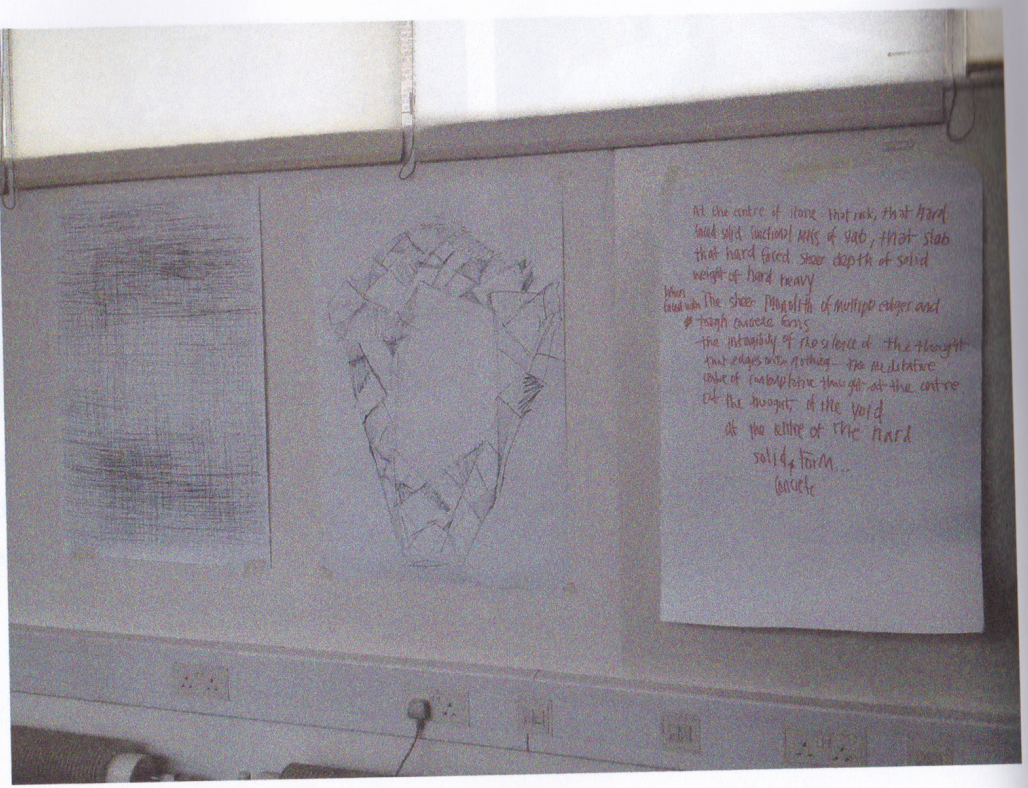
(Katy Connor)

Internet telephony can be distracting – sometimes things move across the frame. Sometimes the noise just appears from nowhere and sits there and perhaps even coalesces with other bits of noise. Flickering geometry of low-resolution with unspecified meaning. These coalesced bits of visual real estate will be given solid 3D form through a process of drawing possibly initially by hand and then rendered as a 3D computer drawing, ultimately sent to a rapid prototype machine to be given solid material form. The flat pixel is rendered with depth.

(Bruce Gilchrist)




Internet telephony can
be distracting - sometimes things
move across the frame. Sometimes
the noise just appears from nowhere
and sits there and perhaps even
coalesces with the other bits of noise.
Flickering geometry of low -
resolution with unspecified meaning.
These coalesced bits of visual
real estate will be given solid 3-D
form through a process of drawing,
possibly initially by hand and then
rendered as a or 3D computer
drawing, ultimately sent to a
rapid prototype machine to be
given solid material form.
The flat pixel is rendered
with depth.


At the centre of stone - that rock, that hard
solid solid function! Mass of slab, that slab
that hard fixed sheer depth of solid
weight of hard heavy
When
faced with the sheer Plane of the of multiple edges and
rough cracked faces
the intensity of the absence of the thought
that edges with nothing - the meditative
state of contemplative thought at the centre
of the thought of the void
at the centre of the hard
solid form..
Concrete

Postscript

BG: I was kind of surprised, my experience I put out something that was quite dry and descriptive and something poetic returned. I was really pleasantly surprised by that. I didn't expect to be moved.

KC: Looking back, the workshop offered a way of approaching the ideas that I was working with at that time from a radically different perspective.

The physical task enabled me to engage with different senses – approaching the thinking not from a isolated approach that so often happens with language (trying to find the words inside one's own head) – but from a more fluid, immersive, engagement with materials at hand. There was also sense of freedom that arose from the fact that these were Bruce's ideas and therefore I wasn't responsible for them. Yet I felt excited, as they resonated with my own project.

Bruce's written description made me consider the work that I had started, as having relevance with a reality on a par with the bricks and mortar of the building materials that I'd been asked to consider 'outside'. These *coalesced pieces of real estate* now have a grounded weightiness, and are framed by a much wider point of view.

Suggested citation

Connor, K. (2013), 'Translating Practice', *Journal of Writing in Creative Practice* 6: 1, pp. 127–133, doi: 10.1386/jwcp.6.1.127_1

From *Solid Light* to Satellite:
the materiality of the moving image as broadcast signal and data

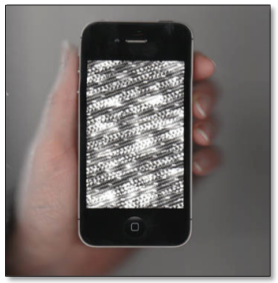


Image credit: Katy Connor
PURE FLOW [mobile edition] (2011)

PURE FLOW launched at Permanent Gallery last year, as part of the Brighton Digital Festival 2011.
It is a live moving image work that visualises the noise in networked GPS data; exploring audiovisual disturbance in its aesthetic value. The piece comes out of a reflection upon the ubiquitous use of satellite navigation, as mobile screens become increasingly ever-present.
Satellites hover on the periphery of our world, both physically and metaphorically, yet materially structure and provide for what we see; when, how, and where we see it. My intention was to subvert the use value of GPS as a surveying and navigational tool, whilst simultaneously providing a way of seeing these invisible streams of pervasive data.

Reflecting on the work one year later, at the second Brighton Digital Festival, I'd like to place **PUREFLOW** in a context of influences and interests, by drawing on the earlier work of the structural materialist Anthony McCall and Nam June Paik - artists whose work shares similar relationships with light, space, sound and noise.
It introduces some ideas that consider the materiality of the moving image, within a context of networked digital technologies, and the position (appearance and disappearance) of arts practice within this dynamic.

—

PURE FLOW is an abstract, generative piece, bordering on animation and pixelated data visualisation. Conceptually and visually, the work references analogue TV static - otherwise known as TV snow - the underlying material of TV and video broadcast, which is curiously absent in digital TV transmission.

In 1965 (3 years after the first satellite TV broadcast) Nam June Paik interrupted the pervasive TV broadcast signal by pulling a heavy industrial magnet over his television set; rendering the network visible as a system. "Magnet TV" brought the information of the Satellite TV broadcast into sharp relief; bringing us face to face with the physical medium of the Live TV Broadcast, its electromagnetic materiality.

Image credit: Nam June Paik

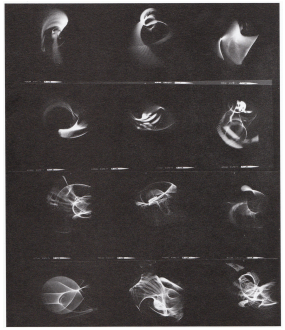


Image credit: Nam June Paik
Screen photographs of 'Magnet TV' (1965)

Anthony McCall's works for projectors continue this conceptual exploratory approach towards moving image technology, in terms of light, space and process. In "Line Describing a Cone" (1973), McCall handles the actual projection beam of light. No longer acting as a cinematic envelope, projected light becomes solid-light, with which people interact as they move around the space. Long pre-dating touch-screen technology, participants touch the solid form of the light itself.

Image credit: Anthony McCall
'Line Describing a Cone' (1973)

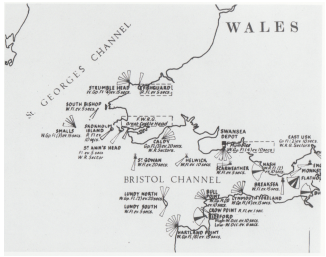


Image credit: Anthony McCall
'Found Solid Light Installation' (1973) detail

In his 'Found Solid Light Installation' a map locates each lighthouse around the coast of England and Wales. McCall considers this distributed network as a conceptual instance of solid-light, re-contextualising lighthouses as moving-image artworks. Here, the solid-light form is no longer bound by the cinematic black cube, nor the gallery space - but relocated into public space alluding to the luminous sites of broadcast. As Sean Cubitt states, when we deal with broadcast and video, projection has a number of new qualities. "Broadcasting gives a new sense of the radiation of light outward not to one but to a huge multitude of screens, each of them in turn a light source. The "projector" is still central, but the screens on which it beams its images are scattered across cities and nations. (Cubitt: *Projection: Vanishing and Becoming* p.412)

At Brighton's Digital Festival solid light can be found in the pocket and on the street - as illuminated smart phone screens respond to live invisible networks - mobile screens, linked to 3G telecommunications and wifi webcasts.

As a miniature, hand held application for a mobile (and global) audience **PUREFLOW** makes tangible the noise generated between smart phones and the multiple satellites, 3G networks and Wifi hotspots that determine its location. Fluctuations in the data produce a sliver of white noise that responds directly to the movement and immediate environment of the device. As a white noise generator, **PUREFLOW** reinstates negative space in the cultural icon of the iPhone.

Just as Paik's 'Magnet TV' intervenes in the visualisation of the broadcast signal (as an image) the **PUREFLOW** software intervenes in the locational data, and the Graphic User Interface of the GPS system.

Image credit: Katy Connor
PUREFLOW [mobile edition] Nighttime view
Permanent Gallery, Brighton Digital Festival 2011

As an installation at Permanent Gallery last year, **PUREFLOW** was projected onto a suspended screen in the centre of the window. The data projections sent shafts of light onto the buildings opposite, across the road and onto the windscreens of passing cars; the reflections mirroring and refracting the signals back and out into space - alluding to the action of the GPS signals between the receiver and the satellites.

PUREFLOW reflects on the position of our bodies, as we traverse and inhabit a series of networks. Placed in the gallery window, the illuminated screen and light projection undermined the stable boundaries between inside and outside the gallery space. It is this networked space that becomes the new background, the white noise from which our contemporary mediated experience emerges.

One year on and these mobile screens become mobile platforms for e-Permanent, a new gallery space where digital art can both appear and vanish into thin air, at any one moment. Like McCall's lighthouses, these mobile screens become luminous sites for broadcast in and around Brighton Digital Festival, and much further afield. One might say that this network will transform every boundary into a threshold... or a platform for the perception of digital art.

Katy Connor is an artist based in Bristol.
www.katyconnor.com

Published by e-Permanent, October 2012
http://www.e-permanent.org/archive-text/text-by-katy-connor-2/

A Conversation with Alain Renaud: Liveness 2012

The aim of Liveness was to explore the potential for emergent understanding and critical awareness through workshops and participatory events, such as field broadcast, live coding and conversation. This conversation between the researchers Alain Renaud and John Hammersley took place in a radio studio at Bournemouth University. The unfolding conversation explores notions of Liveness through the intersection of the different horizons and perspectives of the participants; Renaud's research into networked music performance systems and Hammersley's practical inquiry into the conditions and possibilities of dialogue in contemporary art.

Key words: Liveness, networks, immersive, fidelity

John I wonder if you could say a little about the work that you do?

Alain *The research work I do is very much practice-based research in the sense that I aim to interconnect musicians and have them interact in real time over a high speed network, a speed of 100 megabits a second or more; networks that are not available to everybody but will be. It makes us think about interacting over a network, because it really opens a window to something that is very high definition, very immersive. I do that mostly with music, for example last week I did a concert between Bournemouth, Belfast and California, with pieces by several composers. For example, my piece was for three grand pianos over three locations. Each time I do this I augment this with visualisation and some sort of live electronics with the sound. It gives the impression of immersion. I find that all the networking technologies that are what I call the commodity applications, like Skype, the experience is not very immersive at all in the sense that the experience is a very diminished low-fi experience. It gives you the impression that there is less engagement because of the nature of the technology. There is nothing more boring to me than having a Skype session. You can have an immersive experience over a network by interconnecting spaces. You are surrounded by technology but you don't necessarily see it and you can have a conversation over a network that feels completely natural; but in a way is augmented to what you have when you are in the same room and that is what I define as immersive.*

John does fidelity in what you are referring to still relate to truth?

Alain *Well you can have very rewarding low-fi experiences even with low fidelity.*

John and are you saying there is a connection between immersion and reward?

Alain *Yes to a certain extent yes.*

John what is the reward?

Alain *The reward is that you feel good. You feel part of it. You feel part of something that is real and your experience is not hindered by technology but augmented.*

John so as I understand it, there are two possibilities; when the technology is intrusive, even if it is low-fi or hi-fi…

Alain *To me it doesn't matter. You can have some low-fi experiences that are very beautiful and that are very immersive. But most of the time it is because the technology or the implementation has been thought with humans in mind. For me staring at a screen and having a Skype conversation, I don't really mind that the person appears crystallised or whatever, like pixellated, or the sound is not so good, but what I mind is when applications are very resource hungry; so it is very likely the fan of your computer will kick off. It's very likely that in the middle of a conversation you will have problems with the network. It happens all the time so suddenly the thing will hang up, or whatever. So that is non-immersive or disruptive experience actually.*

John My understanding of that is it's like you are in the flow of your train of thought and it's like you are interrupted in conversation. It irritates you?

Alain *…and it doesn't allow you to think straight because most of the time it leads to a situation where you become so concerned with making sure that the communication is there, that you completely forget about the content, or the sense of what you want to talk about. Whereas, if something is set up properly in an immersive way then you can focus completely on your creativity (if you are a musician) or the subject of whatever you want to talk about.*

John So it could be like having a microphone waved in your face. There is a sense in two or three of the things you've said, are coming between, re-distancing, because even though you are connecting the far removed places of California and Belfast, Bournemouth, what you are augmenting is the sense of being together…

Alain *Absolutely!*

John …in time. Could you say a little bit more about the importance of high definition and augmenting? Is there a sense in which you could go higher than the sort of non-technological everyday experience? Are you trying to over-compensate, over-augment?

Alain *Yes, maybe I am in a way. Because once you start using networks, there are a lot of things that you would have, especially in the case of music that you would have naturally when you play in the same room with other musicians. That's obviously once you start distributing them over a network, you will lose some very basic cues, eye contact for example. Those things you won't ever be able, well maybe in 100 years or so, but now you are never able to replace. True eye contact, is something that happens randomly and is not even directed, so once you take that thing over the network you have to find ways to compensate for what has disappeared in terms of natural cueing. And in order to do that you have tools to help you create… it's a bit like listening to a music track in mono, which can sound beautiful, and you suddenly get yourself in a space, and its in five point one with sounds going all over the place. That as a process can be disruptive or disturbing in itself but in the case of having people connected over a network it can be very useful. You can change localisation of all the sources, have the impression that when you are sitting here someone will be on your left or on your right, or in front or behind you. You can recreate that very easily but what is exciting is to use the network, use the situation to create an experience that can only happen over a network.*

John Let me see if I have got you right? You talked about the human dimension, and the cues, the spontaneous, the unpredictable. There is a sense of things at the periphery, moving, that can't be controlled, programmed, but rather than simply trying to be truthful or maintain a fidelity to the sense of that experience, you are almost trying to conceptualise a hyperawareness?

Alain *To a certain extent I am, yes. Because there has been a lot of, especially in commercial projects with 'telepresence', there have been a lot of efforts made to recreate what they call 'as in the same room experience.' When it comes to interactive, it has a lot of parallels with the concept of* **liveness***. It's like the Sisco teleconferencing system. What did they do first? They said, traditionally people are sat in a boardroom with a table that is oval. So what we are going to do is cut the oval in half. We are going to create the other half of the table, and that will allow us to create an experience that is going to be as if you are in the same room. But in a way it's not because it's so unnatural that, in my opinion, it's maybe a strong statement, but it doesn't wok. So I think we need to look at the network and we have the opportunity to interconnect physical spaces and people so they are not mediating their exchanges through a central server but directly with each other. That brings the opportunity to think about concepts that are dipping into a networked world.*

John A networked world?

Alain *Yes, a networked world? So basically…*

John Another way of thinking about reality is it's a networked world?

Alain *Yes. In a way it is. But that allows you to think about new ways to interact, to position… it's not because you have a table like this. If you have it over the network say, what you have to do is, say if you have four people around that table and you want to have people at four sides; what you have to do in theory is cut the table into four and then you have four bits of that table united by the network. But I don't think it's right to think that way. You need to think, well maybe these are actually real spaces that are different from each other for a start. It's very difficult to find similar spaces, and then you start thinking strategically about how you can position your different resources and how they are going to interact with each other, which creates an environment, which is such that you couldn't recreate that in real space.*

John It's a fiction?

Alain *It's a fiction in a way.*

John So it's almost moving away from low-fi/hi-fi, we have got low fiction and high fiction?

Alain *To a certain extent, absolutely.*

John Where fiction is believable? So truth is the sense, when something is unbelievable it interrupts, and when something is believable it merges?

Alain *Yes. Exactly.*

John But your practice conveys a sense of seamlessness; are you aiming… or maybe minimalism?

Alain *There is a lot of minimalism in what I do, or aims to achieve minimalism, because I think that, even in a radio studio like this, I for example find it a very unnatural setting, and in a way it's not that different from connecting two places via a network. When you look at those guys over there [looking through an internal window to the next radio studio], it's the same except that you have longer distances. The setting in itself is just not good to see all those cables around and having to know that it is going to be heard, so I have to speak in that way. It's not natural.*

John This space has technology in mind before it has the humans in mind?

Alain *Exactly.*

John And is that where the connection with minimalism is, because if I think of minimalist art, the human seems always at the centre, experiencing.

Alain *To a certain extent, that is exactly what I am trying to do with these network situations. Where people just walk into a space. They will always be aware that there are people on the other end, and those people may be thousands of miles away, but they don't have… When I design those spaces, I design them so that they don't have to pick up a microphone to be heard. I know it sounds a little impossible but you can do that very easily with wireless microphones for example. You just wire someone up and they can walk into that space and then depending on where they are located they can capture the coordinates and spatialise them in the space and stuff like that. And people in that sense, people completely forget, and I feel well placed to talk about this because I've done so much of this, basically making music over the network is one thing, but there is the whole preparation of the whole thing which happens over the network as well. And we've come to a point right now where it's not even in our mind that we are actually separated by such long distances and that we are in different spaces. It's very natural.*

John In what you are suggesting to me there are elements of forgetfulness in **liveness**?

Alain *Yes to a certain extent.*

John Which seems the opposite from a lot of…

Alain *Well I think it's what we need to get to. If you look at some of the demonstrations today, a lot of it for me was hindered by technology that didn't work or was unconvincing. So you end up detaching yourself from the whole thing.*

John Because at a fundamental level it didn't place the experience of the participants first?

Alain *Exactly. It was to showcase. Well I know how it is with video. It is extremely complex, but it was just to showcase some technology. But where does the human come into that? But I think that is leading to a lack of… if we are able to talk about what is being live or not, [it leads] to a lack of credibility because basically the stuff was not live. It was something recorded, pre-recorded or played back seven seconds later. I'm not saying that because it's asynchronous it's not live. I think there is a limit.*

John Is there a parallel with the concept of tools and I think it was Heidegger and handedness, when you use the tool as if it's part of your arm, or whether you are… it's in tune with us. It's no longer an end…

Alain *It's part of us.*

John So, to come back to forgetfulness, maybe it's forgetting?

Alain *I don't think it is forgetfulness. I think it's more like unawareness. So it's like you show up in a space, and you know that there are some other people that can hear you, can talk to you instantly but you are not necessarily aware of the whole technology there; simply because when you walk in, you don't have to be completely wired, or to actually interact via a medium which is the case most of the time. We have to interact via a computer screen, keyboard and a mouse. That's how most network interactions take place today.*

John There is another suggestion that we are in multiple relationships in your work, that your work is talking about multiple relationships. We can relate to the space we are in, we can relate to the objects, which are part of that space but can intrude and somehow feel not a part of that space, at the same time we are trying to relate to other human beings on multiple levels; through the music, through gesture, and through the leakage of unexpected cues. Metalanguage?

Alain *Yes.*

John So in a sense **liveness** is receiving and coping with multiple relationships and deciding or trying to prioritise an awareness of one mode of relating over other modes of relating. Which element of that complexity of relating to time, space, physical reality, other human beings… What is the essence of what you are trying to remain aware of by becoming unaware of other things?

Alain *That's a difficult question because there are so many dimensions in this.*

John So it's not just one thing?

Alain *There are two things that contribute to* **liveness** *basically. Primarily the participants, the interactions, sorry, well in the case of music between the performers but also it's a little untalked about, the interaction between the physical spaces. How do physical spaces connect to each other? It may sound a little 'out there' what I am trying but it's very important to think about the relationships between the spaces themselves. For example right now we are in a very dead room acoustically and I'm convinced it effects the quality, someone like me who listens a lot to the environment we are in, it effects the quality in a certain way, not necessarily a negative way but the quality of the conversation.*

John You mean the deadness?

Alain *The deadness of this room.*

John Inevitably creates a deadness in the conversation?

Alain *Exactly. If we were having the same conversation in the middle of a cathedral that would be the exact opposite in the sense that it is such a live environment.*

John Is it too clichéd to say atmosphere?

Alain *Atmosphere. But mostly the acoustic atmosphere. So that is the second strand to think about in terms of awareness, or the things you have to be aware of in order to…*

John …become unaware of them?

Alain *Yes. To become unaware of them.*

John So it is designing. Literally de-signing so you become conscious of the communication in order to decide what to edit out.

Alain *Exactly, because if you say connected this space with the place where we are going to be tonight, which has a much longer reverberation time, which is a big space; through interconnecting those spaces with a network you can actually bring some of the atmosphere of this space and I did this last week, you are in here but if you close your eyes and talk you really feel like you are there.*

John That's complex.

Alain *It's complex in terms of maths. You've heard about recording studios, in the past they didn't have the technology to have reverberation units. It's like a device that allows you to add reverberation to a space that is dead. So if you were playing guitar in here you might want to route a bit of that signal to that reverb unit so that it feels augmented.*

John So you are mapping the way sound maps that space. The sound is the echo of that space?

Alain *Yes. So what happens in real space if you connect this place to a big concert hall and you have your sound go through speakers, and you have a very special microphone in the middle of that room, you will be able to, in a tri-dimensional way, to re-inject that atmosphere in real time into that space, into here. So you clap your hands and it will extend with reverberation.*

John Let me see if I've got this. If we are having a conversation or if I clap my hands here it's being recorded and played back in here?

John It's being recorded and played back in here but also if you go through a network or if you interact with other people, your sound will be played somewhere through speakers, somewhere in another space.

Alain *But it could be played not with the sound quality of this room, but you could map onto it as if the clap had happened in the concert hall.*

John Yes. In fact the clap happens in the concert hall. But that is where it leads to the whole problematic of **liveness**. The **liveness** of the space itself because the space, that's the definition for me of **liveness**, there's **liveness**, for me, which is the actual act of interacting between individuals; our conversation here is part of live things, but there is also the **liveness** of the space itself, the physical **liveness**, and a more technical space creates less texture?

Alain *Yes, because there is so much technology that it actually has…*

John A little bit of detail is lost with every layer?

Alain *Yes. Absolutely.*

John So then we are back to the fiction. That's what the high fidelity and the augmentation… it's putting in contextual detail but not so much that it interrupts?

Alain *Exactly.*

John Back into the dominant or most important communicative or relational mode, be it piano playing or conversation. Doing what the mind does subconsciously, because when you're having a conversation in a noisy bar my mind would be filtering out the conversation to the right of me.

Alain *Potentially yes.*

John Well yes, depending on how or what they were talking about. But the mind tries to do that?

Alain *Yes.*

John We think this room is quiet but we can sort of hear the chair creaking and…

Alain *Yes you can hear the conversation taking place outside.*

John What do you think you are still trying to understand about **liveness**? Is there a sense of the unknown about it?

Alain *For me the main issue I have had. You know when you do research you always find people who are willing to criticise it, which I think is good, and one of the main issues I have with what I do in terms of validating the fact that it's live experience, related to* **liveness***, is that people are saying, but you could do this with a plug-in, or you could do this by pre-recording your thing, in which case it wouldn't be considered live. So for me, what I'm aiming to do, coming back to what I mentioned about this morning about authenticity; how do you know what you do and what you live is real? Because sometimes you have so many augmented or immersive experiences, so many things that sound so good or so different from what people are used to, that a lot of people doubt it is actually happening, it's actually real. And I think for me in terms of what I haven't solved is to actually show them it's real. The people on the other end are live people, that you can be playing with, so obviously for the people taking part in the actual experience like the performers, they know it's real because if they stop playing then the whole thing goes belly up. But the audience is another beast to convince and that actually applies to a lot of things today, even a traditional pop/rock concert. We know that half of the things being done are play back actually. People don't really play anymore, so how do we know if people are playing or not?*

John Trust? I guess that is a whole new conversation to open up. But let me just see if I grasp that last question. You were talking about, 'how do we know what we do and what we live is real?'

Alain *Yep.*

John Is it authentic? But when you reintroduce that into the scenario I'm watching a pop band and I'm watching them because I have a certain belief about who they are, that is important to me, then if they are faking it, the investment I place in turning up to that concert means that I have deceived myself. So one of the things about technology seems that when we suddenly realise we are being deceived by technology there is perhaps a moment of realising you can't always trust yourself, which is a mini existential crisis.

Alain *Well, that's a good point, and I think as technology increases and is more and more present those things are going to be easier to do. People will feel increasingly cheated. I think.*

Liveness

Authors
John Hammersley, Sally O'Reilly, Alain Renaud

Editors
Katy Connor, Tom Davis

ISBN 978-0-9574430-0-6
Published By EMERGE – Experimental Media Research Imprint
Designed by City Edition Studio – www.cityeditionstudio.co.uk

www.co-laboratory.org

LIVENESS

Liveness was a one-day multidisciplinary exchange lab for practitioners, exploring concepts, philosophies and technologies of the LIVE through creative practice.

The first in a series of experiments of conference and research formats hosted by the Experimental Media Research Group (EMERGE) at Bournemouth University Media School.

Date
Friday 27th April 2012

Keynote
Sally O'Reilly

Organisers
Katy Connor
Tom Davis

Chair
Neal White

Workshops
Field Broadcast:
Rebecca Birch & Rob Smith
Trevor Hearing
Jo Tyler
Thor Magnusson

The Emely Cafe:
Rosalie Schweiker

Artist Interviews:
John Hammersley

Participants
Katrina Brown
Ryan Curtis
Christine Ellison
Hedva Eitanani
Antje Hildebrandt
ivonaattes
Nikki Pugh
Alain Renaud
David Rogers
Joanne Scott
Neal Spowage
Joe Stevens
Lizzie Sykes
Susan Sloan

Keynote Speech

Sally O'Reilly

I'm going to assume that we're all reading off the same page. I know that one of your key texts that you handed out pertaining to today is the Auslander, Chapter 2 on *liveness and that is the position that I'm kind of operating from as well. Which is that I don't really believe in these Live Art distinctions between *liveness* and non-*liveness*, or the claims made for *liveness* that it's authentic, risky, radically anti-capitalist, inclusive and somehow more real and spontaneous.**

* Auslander, Philip (1999) LIVENESS: Performance in a Mediatized Culture. London: Routledge.

I don't believe that, so I'm just going to quickly run through – so that we all don't believe it hopefully – I'm going to run through some anomalies which overturn some of these Live Art assumptions, made by the bleeders and chuff-stuffers, as I like to refer to them outrageously. If anyone would like to take me out over that later on I fully expect it.

So, let's take for instance the idea that Live Art or *liveness* is more authentic. You may be tempted to think that if I just speak off the cuff whilst delivering this keynote speech I somehow know the material better, or I'm more ardent about it, it's somehow more meaningful. Whereas actually, if I have pre-written and edited it, it's more likely to adhere to what I actually do really think. If I read it out to you it'll be much more accurate in terms of what I really think on the subject. So later on I probably will actually refer to my rather extensive notes.

Authenticity and language – whatever authenticity is – have a really complex relationship to the consciousness and the subconsciousness, and indeed knowledge in and the pockets of knowledge that are stored within consciousness and subconsciousness. When one is speaking under pressure language is not a well-behaved creature.

And if we look at some anomalies within the claims for the ontology of Live Art as opposed to theatre, we can look to Augusto Boal's 'Invisible Theatre', which was a format whereby he and some performers, would go out into the world, like maybe a restaurant, and they'd order a meal and they'd start to have a debate with the waiter about why they shouldn't pay for this food and then, everyone who was sitting around the restaurant – they wouldn't be aware that this was prescribed, this rehearsed, predetermined and, to an extent, Theatre – they would think this was a spontaneous discussion that was happening in their real social time and space, and therefore they would enter into a critical discussion on the social and political aspects of the exchange value for food.

But then this format has been taken up by mobile phone companies who employ people to have similar conversations in public space on tubes, on trains about what contract they have. And so what was a sort of radical authentic critical debate on something important is co-opted by Capitalism.

And then if we come at it from the other direction from the mediated image – this is a piece by Mona Hatoum. You encounter this video screen and a plait of hair hanging down and you're invited to pull the plait of hair and the face the expression changes it sort of goes OOooo or OWww. And you think, Oh My God, how have they done this amazing bit of video editing? That's a kind of clever bit of avant-garde technology that I don't quite know about – or maybe you do – and then after a while you realise actually it's a Live Feed. Mona Hatoum is there behind the wall, and that is her plait you're pulling and she is saying OWww because it's actually happening there and then – so the mediatised image isn't necessarily inauthentic or not real.

Er and the idea that it is that, um oops sorry (*beep*), no we don't want that one just yet.

The idea that *liveness* is spontaneous is also patent nonsense, because what about rehearsal and improvisation? Comedy improv, which I saw a lot of in the 'Last of the Red Wine' project, but also music improv? I understand it's not just total freeform. With comedy you get to understand, if you see enough of it, that the performers are finding routes through material, and they're familiar routes through material, and they bend the apparently spontaneous input to their will, so they're quite quickly on terrain that they know how to manipulate to comic ends. And also, wit – the spontaneity of wit – has been historically questionable in some societies at certain times; that kind of quick spontaneity was too penetrative and sort of rude, whereas actually the rehearsed milieu of small talk was much more acceptable.

And the idea that *liveness* is more intimate I think is also hokum if we – skip over that one for now. Jean Michel Jarre – I saw Jean Michel Jarre in Paris in 1990 or something, and it was the most unintimate experience of a live event ever because he was about a million miles away, a tiny spec. But also if you go to live performance events in art galleries, a lot of people producing in that context don't really understand the very simple thing of sightlines. So you just get the view of the backs of people heads – which is also not very intimate in terms of your relationship with the performer.

But if we think of media and broadcast phenomena, I want you to watch this little clip from the biopic about Andy Kaufman the American comedian. I'll just play it – you'll get it.

🐭 *Man on the Moon (1999) Practical Joke Scene*

So it's not running very smoothly. Sorry I'm going to give this a little moment to catch up with itself because I'm running this live, ladies and gentlemen.

(*pause*) In fact, I'm going to run it from my whatsit.

Right try again – beg your pardon.

🐭 *Man on the Moon (1999) Practical Joke Scene*

So there Kaufman, by appearing to adhere to expectations, finds himself in a position of control whereby he can divert expectations, and create a kind of strange ontological confusion that happens at quite an intimate level within the home. The relationship between the viewer and the television becomes fraught along a very unexpected axis, so I would say that that is one particular occasion whereby the mediation and the broadcast of an image can create an intimacy that could be akin to the claims made for *liveness*.

And to find an anomaly to the idea that *liveness*, or Live Art in particular, is radically Anti-Capitalist, we just have to think about Tino Seghal, and I have no image of Tino Seghal because he doesn't allow his performances to be photographed at all, and yet they are eminently collectible – and he sells his performances for the going price of a blue-chip artist, so there's little to be said anymore about the political claims for *liveness* I think.

And also there's the claim that *liveness* is inclusive and de-skilled, and yet if we think of mediatised content – just look at user-generated content. This is totally inclusive and deskilled. And, conversely, the ontology of the stage as being within the same matrix as the viewer, is kind of made a nonsense of when you go to the ballet – this is Karen Kilimnik the painter's ballet design – and there is an adherence to the ideals of virtuosity within her live productions too.

But then when you look at someone like Jerome Bell he always has somebody standing at the front of the stage – like this – making eye contact for way too long. Just to make the point that, ooh we are all here together. So he's reasserting this kind of Live Art ontology: we are all here in the here and now all together. So I'm not saying that one thing is one thing and one thing's not another, but everything is convoluted and everything is swapping over from one category to the other all the time.

The idea that *liveness* produces political engagement: we just have to think of last week's Marathon as a precursor to the Olympics, which Noam Chomsky identifies as state-ordained irrational jingoism, and we just mindlessly watch all these people flinging themselves about and kind of forget about the Nationalist messaging that's going on with all of this. And then again there are some very good radio debates being led by Professor Mike Sandel at the moment on (BBC) Radio 4, where he performs a very rehearsed Socratic method where he interacts with an audience and their criticality. Their critical relationship as a subject matter becomes very apparent in this re-prerecorded broadcast medium.

This is Ian Saville,

🐭 www.redmagic.co.uk/video

who is a socialist magician and he performs tricks that are dialectically opposed to the bourgeois magician, and I'll not show you all of this clip now but this is a stage show that he does called 'Brecht on Magic' where he uses the patent unrealness of ventriloquism to demonstrate Brecht's 'Verfremdung' technique: that of distanciation, so that the audience realises that what they are looking at is not real, and is therefore to be judged and to create a critical stance on.

And then there is the very real on stage moment when Tommy Cooper died onstage, which is that classic clip that live art people hold up as being the ontological marker of *liveness*: that is, death. (*clip starts*) I'd never seen this clip before.

🐭 Tommy Cooper Clip: www.liveleak.com/view?i=b77_1240142064

So that is an extraordinary moment and considering it's supposedly magic, specifically secular magic, it's an incredible rupturing of that genre, where we take it for granted that nothing that we see is real. Which brings me to Uri Geller, who is a very unusual sort of magician, and he is he is actually not really taken seriously. I don't think he is even allowed in the magic circle. Because he makes too many claims for realism. He claims to be operating from the mystic plane, which is not what a secular magician would ever claim. They are working very much in the realm of illusion, where Uri Geller, you could say, is working in the realm of delusion. (*Laughs*) And then the idea of risk: There is not really a great deal at stake when it comes to just bending a spoon. It may be happening in front of you and be a bit confusing, but there is not very much at stake, but the place where real risks are being taken in terms of the display of mediated acts or moments, I think, are the whistle-blowing websites. This is the collateral murder footage that was broadcast on Wikileaks a few years ago, which was incredibly pivotal in outing a lot of American foreign policy, or military procedural line crossing.

So, all of those claims for *liveness*, they are all very positive, but I think we can see they can also be applied to recorded broadcast and mediatised imagery. And on the downside, *liveness* is thought of as being elitist because it is not universally accessible, due to its temporariness and its singularity. But then, this is precisely what gives *liveness* its value as cultural capital because it presents the auratic original, albeit with a strangely mutated aura to more people who then can recognise it as an auratic original. And we are back in the realm of the valuation of the unique object, albeit reiterated and mechanically reproduced and distributed.

But anyway, *liveness* doesn't preclude synchronous or diachronic reiterations. This is the Blue Blouse group, who were operating throughout the Soviet states in the 1920s. They started off reading the newspaper to illiterate proles and then the productions became more and more elaborate: they ended up being full-scale musical, theatrical productions that would relate information on new irrigation systems for instance or news on the new manager of the new sock factory in Riga, for instance. And these groups popped up simultaneously through out the Soviet states – I think there were over 120 groups round about 1923, who were all distributing the same content. And conversely representation and distribution, rather than being democratizing, can be thought of as amplifying romantic notions of valorised cultural producers. So again I'm just making the case for there not being a separation, but a categorical shift between the two modes all the time. And now I'm going to refer to my notes a little bit more, because now I want to get a little bit technical about how we can how we can identify *liveness* as doing something that mediatised stuff, I'm just going to call it stuff for now, can't do.

So … I think that when people makes claims for the ontology of live performance they mistakenly place it in antagonistic relationships with recorded, reproduced and distributed representations of physically performed phenomena, whether these are speech actions or cultural forms. But, but what if we extruded our consideration in the other direction, back towards the intentionality, instead of effect? What if we considered the relationship between a performed phenomenon and its inception? I've a feeling that his might account for the inconsistencies that I was just talking you through, just now. And I think it is a really good idea to always look at the language that's being used when you are trying to figure out what something is and how it's operating. Because language carries a lot of implicit knowledge that we have forgotten or that we never even quite clocked in the first place.

So, if we think of media and mediation they are obviously epistemologically of a type, and the root of these words is pertaining to the middle or in-between-ness, and in its applied meaning in this sort of context – in the context of communication technologies – a medium is an intervening agency, means or instrument. 'The Media' is a collectivised noun that appeared in the 1920s to refer to the burgeoning broadcast technologies, as we know. But prior to this a medium would have referred to a conductive communicatory channel, usually a person communicating between the living and the dead. And critical discourse has absorbed this provenance into Derridarian ideas of Hauntology – that is, the ghost of the past in all that is present. So that in relation to mediatisation the illusory resuscitation of the past or the replacement of elsewhere that television performs might be thought of as spectral, and the intangibility of the pixel becomes a ghostly apparition compared to the blood and bones of the live performer.

But my suggestion is that this distinction between the live and mediatised, and flesh and spectral, and real and irrealism't so useful either. And it might even be irrelevant. I think it's certainly not possible to say that one is better than the other. So, I want to go back to a really, really basic definition of media – and that is the intervening agency a means or instrument – to think about what we really are dealing with here. And, I think the word 'intervening' is the really important one; because it begs the question what is it that's being intervened with? And, it suggests that there is some state or object that's being subject to mediation, and that there's some originating source to be mediated. But if there's anything that the 20th century has produced in terms of understanding, it is that nothing is singular, autonomous and fixed, that all is contingent and historical, that everything is in flux in relation to its context and conditions. But, then again, there are currently many rumblings kind of to the contrary, in terms of object-oriented ontology. But there's still no suggestion that there is a monolithic objectivity that lies beneath subjective perceptions. So, what is it that we are dealing with? Because it is necessary to take something as an a priori, otherwise it's irrelevant all the way down. And I'm going to work now on the assumption that the entity that is being intervened with or the thing that is being mediated or mediatised is the idea. And, and I mean this in a post Kantian sense, where the idea is a nebulous non-form – although I understand again that there is a current suggestion that an idea can be described objectively as the relation between potentialities and intentionalities. But I don't have time to go into that; and I haven't read the essays yet.

So I just want us to run a little unscientifically with a common assumption of what it what it feels like to have an idea as approximation for now. But then, of course, there is the problem of how you tell what's the difference between an idea and just another thought. And we also have to think about how the idea gets in there in the first place, but can we just say that an idea is a notion conceived by the mind, which may of course change at any moment. And, just to be clear, I am not referring to Platonic ideas, which are archetypes as distinguished from relations to individual things. This is very much a post-Kantian idea that has been born of other ideas, and it is mutable and vulnerable, but it's a point from which I would like to depart for this last section, as we consider this process of mediatisation.

Woah, better be quick.

Now, we probably understand the word mediatisation to mean the way that mass media shapes modernity and how the political commons is wrought through the public's understanding of politics as it's represented in mass media. And it suggests a twist in pre-modern hierarchies, where subjects are subordinate to the sovereign, because the media itself becomes a kingmaker, or a king-breaker, thereby requiring any leader to be subordinate to it. So there's a new category of media mogul that emerges. And so, in a mediatised world, the food chain of prevailing influential institutions is consequently reconfigured somewhat.

But, there's a more specific – going deeper into entomology now – there is a more specific and earlier definition of the word that I think is useful to this discussion, where mediatisation refers to the loss of imperial immediacy. Broadly defined, it is the subsumption of one monarchy into another monarchy in such a way that the ruler of the annexed state keeps his sovereign title and sometimes a measure of local power. For instance, when a sovereign country is annexed to a larger realm its reigning count might find himself subordinated to another sovereign ruler, but nevertheless remains a count of sovereign rank if not actually fully sovereign in fact. And his subjects owe allegiance to the higher Prince through him. And so his sovereignty is said to be mediatised, that is rendered intermediate. The term mediatisation was originally applied to the reorganisation of German states during the early 19th Century, but the process has been going on since the Middle Ages.

So we find ourselves thinking about immediacy and power and representation and the deferment of immediate power to another body elsewhere. And this does sound emasculating, but amplification is itself a deferment of representation, and yet this is often considered empowering, because technology, after all, is the amplification of human capacity. A teacup is an improvement on cupped hands, for instance, and the loudspeaker is a really improved voice box. So, to mediate an idea is to enlarge and make efficient its communication and so the loss of immediacy is made up for by extended reach, and both these conditions come about because of the innate state of displacement, in time or space of that which is being mediatised. But I would suggest that mediation or mediatisation is not just globally tending, it's not always moving outwards. It happens daily at even the most intimate levels and 20th century sociology, and I am thinking particularly about the writing of Erving Goffman here, suggests that we're perpetually self mediatising, we're forever performing an idea of ourselves even to ourselves at all times.

(*Bang*) And there goes a collapsing desk.

Camus wrote about the performance of the barman as barman, the barman performing or over-performing barmanery to himself and to everyone else. So intersubjective relations, I'd suggest, are all subject to intervention by ourselves, and so even the assumption that technology is necessary to enact mediation or mediatisation is also brought into question. Because are we not at all times, in every speech and action we perform in daily life, intervening with our own projected selves? So the complex interrelations between thought and knowledge, perception and expression extend within the subject as well as between subjects, so subjectivity is itself a mode of self-intervention and mediation in a way. So this leaves us in a totally dynamic indeterminate soup, where everything in the entire universe is included in this subject of mediatisation, and this is the kind of classic end of history point, that these sort of papers get to, isn't it? Which is usually quite a dead end and annoying.

But I think this is because we tend to think about these things in the post-structuralist mode, and because we are bent on indeterminacy, privileging viewership over authorship and intention, because these are supposedly outdated, romantic and rather illiberal notions. But I want to return to the originating idea again and talk solely as a producer – and I know that many of you are producers as well. So you'll hopefully start to realise that when you consider *liveness* as a viewer, it is very different to the way that you consider it as a producer.

As a viewer I don't valorise *liveness* over recorded or mediatised material. I don't place them in opposition to one another, but along various interrelated continuums, as I outlined earlier. But as a producer I feel there is a really distinct difference between the ways that I realise my idea, depending on whether it is live or not. The process of making a live performance is undeniably different from the process of, say, writing an essay for publication, and the main difference I should say it that with *liveness*, there is no post.

There is no post-production for starters. There is no insertion of special effects. Or rearrangement of the order of words after the fact. Where as in the video editing suite or editorial office we can rearrange things to rematch what it was we intended to say. So whether scripted or unscripted, in a live spoken word performance, such as this, the words must be spoken in the order that is intended for the audience to hear them in, and the brightness and contrast must be just as I intend and the loudness and the timings can only be just as they are, as they can't be adjusted later. This is all obvious stuff, but it's important. You see, everything must be ready, must be in place rather than placed there later. And it becomes clear that forward planning, rather than retrospective manipulation is paramount. And intentionality is first and foremost. And there are of course historical precedents for the deskilled and anarchic non-planned happenings – and I'm thinking about Alan Kaprow's Happenings where, and I talked about improvisation as well and I think I've refuted that, but also with Kaprow's Happenings the major element of post-production for him, I think, is that he just decides beforehand that what ever happens is actually part of the thing. There's this sort of post-hoc rationalisation of whatever it is that occurs, and that becomes post-production to an extent.

OK, a live event is a feat of forethought – I have written here – and the mobilisation of contingencies based on predicted arrays of potential outcomes and rehearsed routes through the material, which ranges from the totally controlled to the statistically likely outcome. So the producer thinks of all possible outcomes and hopefully matches their intention with the expected range of outcomes. Which is what I find particularly thrilling about making a live work in contrast to writing, where in the final edit the whole universe of vocabulary is still available for substitution with what is already on the page. Whereas the moment of performance is entirely contingent on what work has gone before and what efforts and insights have gone into the planning and rehearsal stages.

There is no post.

And so, I think after a century of indeterminacy, where everything was post-something or other – post-modernism post-structural, post-fordist, postman – I think this lack of post is the key attraction of *liveness*. There is an apparent intention and authorship underlying the persistent subjectivity of meaning. And perhaps this is what we crave, I think, after a century of willful flux. There's almost a teleological sense of returning to something approaching historical materialism in micro, where the outcome is the result of very real circumstances here in the room, and not just the subjective interiority of the audience. But this does rely on the producer or the performer having thought of absolutely every possible outcome in advance and forcing this towards the desired effect, although this is of course is impossible, but I think the experienced producer has an increased chance of making these two things meet, because they know how to expect the unexpected. So, for instance, I fully expect that some audience member might jump up at any minute. And I can in fact see one; and I know, because I happen to know Neal has this tendency to streak so don't worry, I've preempted this, Neal. You can just take your seat again, thank you very much. You can't keep him down in these situations. So I've taken the liberty of preempting your radical clothes-shunning moment. It's his 'you've run out of time' moment – I know I've got my eye on the watch, I knew it was coming so I am actually, I'm going to perform for you an auto streak to end this live moment for you all.

I'm going to streak myself because I was expecting you, sir.

Thank you. (*Laughter and applause.*)

Appendix 19: Ethics Release Forms

Ashley Scarlett	Email Release
James Bradbury	Interview Transcript Release and Email Release
Prof. Genhua Pan	Email Release
David Roden	Email Release
Sophie Warren	Email Release

Tel +44 (0) 1202 965360
media@bournemouth.ac.uk
http://research.bournemouth.ac.uk/centre/emerge/
http://colab.org.uk

Bournemouth University

Participant Consent Form for PhD Research

Katy Connor

Bournemouth University

Project:

Untitled_Force: 3D Print as Poetic Praxis

Dear Ashley Scarlett

I am writing in order to ask you to participate in my PhD research project, named ***Untitled_Force: 3D Print as Poetic Praxis,*** by permitting an extract of our email communication to be included in the final PhD exegesis.

The purpose of this form is to provide you with information so you can decide whether to participate in this study. Any questions you may have will be answered by myself, Katy Connor (the PhD researcher) or by Prof. Neal White (my Supervisor) whose contact details are provided below. Once you are familiar with the information on this form, have read the extract included, and have asked any questions you may have, you can decide whether or not to participate.

If you agree, please sign this form or else provide verbal or email consent if you do not wish your name to be registered on this form. Please also indicate whether or not you are willing for your contribution to be named. Your email address will NOT be included as part of the PhD submission.

Please note your participation is voluntary. You may decide to withdraw permission for your data to be used, at any time, up to 20th July 2016. In this case any notes, emails records and other data will be destroyed.

Project Description:
You have been asked to participate in an artistic research project that develops work through a practice-led process of 3D Print fabrication.

Purpose of the Study:
As a PhD candidate in Experimental Media, my artistic research investigates the materiality of digital process, through practices of making, critical analysis and reflection on production in the field of contemporary media arts. Through public exhibitions, my artistic practice introduces audiences to innovative and novel ways of understanding digital technologies. These works, together with written analyses, question how technologies frame, model and structure our perception and understanding of the natural world around us.

This particular body of research, named ***Untitled_Force: 3D Print as Poetic Praxis,*** explores the relationship between my blood and the machinic, through a series of metaphorical and material investigations. The PhD enquiry considers how the body becomes re-materialised, becoming techno-corporeal abstraction through techno-scientific processes. This is my distinct contribution to knowledge.

Throughout the written exegesis, *poetic praxis* is developed as my unique method of approach—both initiated and grounded by the nature of practice-led artistic research (praxis)—and philosophically inflected by *poesis:* processes of questioning and reflection that reanimate key aspects of current techno-scientific practice.

In the PhD exegesis (Volume 1: 40,000 words) I reflect upon a series of works fabricated through both two and three-dimensional print practices. I also provide a critical analysis of emergent material practices of 3D Print (also known as Additive Layer Manufacture). The exegesis elucidates the artworks, their materiality (as Nylon 12) and concludes by considering future scenarios of biological techno-scientific practice, in which the body itself becomes 'fabricated'.

A portfolio of practice (Volume 2) is presented as a parallel volume, which allows the reader to navigate documentation of the artistic research process. These stem from early studio-based experiments; tacit-intuitive approaches to materials and processes which foreground later, lab-based fabricated works. The portfolio includes photographs of the completed series of art works, collectively named as *Untitled_Force* (2011-2015) alongside documentation of their public exhibitions, reconfigured as sculptural installation at three different sites.

I argue throughout that *poetic praxis* as a methodology is a vital means of approach, revealing the unknown within existing instrumental research paradigms.

Use of the data

I have attached a PdF of the specific instances in which your email is referenced in the PhD - namely **The Introduction,** page 16 and **Appendix 2.**

The email extract will be quoted as shown and used therefore to form part of the written document. If you wish to receive a copy of the full dissertation, I am happy to provide you with an electronic reading copy.

Risks
There are no foreseeable risks from participating in this study.

Compensation
You will not receive any type of payment for participating in this study.

Statement of Privacy and Confidentiality

In any publication based on the findings of this study, the data presented will contain no identifying information that could associate it with you (including your name and email address) unless you specifically request to have your real name associated with your responses - see below.

Contact Information

My telephone number is: [redacted]

My email address is: [redacted]k

Alternatively, you may wish to contact my Supervisor, Professor Neal White at [redacted]

Confirmation and consent

I confirm that I have freely agreed to participate in the PhD research project of **Katy Connor,** named ***Untitled_Force: 3D Print as Poetic Praxis.***

I have been briefed on what this involves and I agree to the use of the findings as described above.

I give / ~~do not give~~ permission for the extract of the email to be used, as shown in the PdF extract:

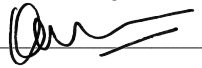
I give / ~~do not give~~ permission for my name to be included in the PhD exegesis.

Participant signature: 

Name: Ashley Scarlett

Date: June 7th, 2016

I confirm that I agree to keep the undertakings in this contract.

Researcher signature: 

Name: Katy Connor

Date: June 10th, 2016

Please keep this form for future reference.

Bournemouth University

The Media School

Informed Consent Form

Digital Tides: **interfacing the technological sublime.**
A practice-based investigation into the material qualities of digital media processes.

Katy Connor
Bournemouth University

Project Description:

As a PhD candidate in Experimental Media, my research investigates the materiality of digital process; through practices of making, critical analysis and reflection on production in the field of contemporary media arts. Through public exhibitions, my artistic practice introduces audiences to innovative and novel ways of understanding digital technologies. These works, together with written analyses, question how technologies frame, model and structure our perception and understanding of the natural world around us.

Procedure and Risks:

I would like to record this interview, if you are willing, and use the digital file to write my material. I will record the interview only with your written consent. Please feel free to say as much or as little as you want. You can decide not to answer any question, or to stop the interview any time you want. The files and transcripts will become the property of the *Digital Tides* project.

If you so choose, the recordings and recording-transcripts (or copy of notes taken) can be kept anonymous, without any reference to your identity, and your identity will be concealed in any reports written from the interview.

There are no known risks associated with participation in the study.

Benefits:

It is hoped that the results of this study will benefit the academic and media arts communities, through providing greater insight into the practice and culture of contemporary media arts practice.

Cost Compensation:

Participation in this study will involve no costs or payments to you.

Confidentiality:

All information collected during the study period will be kept strictly confidential until such time as you sign a release waiver. No publications or reports from this project will include identifying information without your signed permission, and if you so choose, after your review of the materials. If you agree to join this study, please sign your name on the following page.

Weymouth House
Talbot Campus, Fern Barrow
Poole, Dorset BH12 5BB
United Kingdom

Tel +44 (0) 1202 965360
Fax +44 (0) 1202 965530/965099/965875
media@bournemouth.ac.uk
www.media.bournemouth.ac.uk

VAT Reg. No. GB 504 4921 66

Final Consent Form

Digital Tides: **interfacing the technological sublime.**
A practice-based investigation into the material qualities of digital media processes.

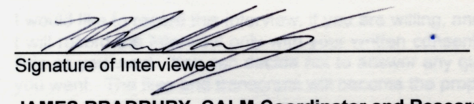
Dear Participant:

This form gives me final authorization to use material from your interview in ***Digital Tides***. *A draft of these materials can also be presented to you for your review, correction, or modification. You may grant use rights for this draft "as is," or with the modifications you specify, if any. See "Conditions" at the bottom of the form*

I, James Bradbury, hereby grant the right to use information from recordings and or notes taken in interviews of me, to Katy Connor of Bournemouth University Media School, and as presented to me as a draft copy. I understand that the interview records will be kept by the interviewer and the project, and that the information contained in the interviews may be used in materials to be made available to the general public.

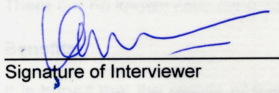
JB *By initialing here, I also agree to be identified by name in the project and related materials.*

JB *By initialing here, I also agree to be identified by photograph in the project and related materials.*



Signature of Interviewee Date: 02/12/2014

JAMES BRADBURY, CALM Coordinator and Research Fellow
Centre for Additive Layer Manufacturing (CALM)
College of Engineering, Mathematics and Physical Sciences
University of Exeter
[redacted]



Signature of Interviewer Date: 01/12/2014

KATY CONNOR, PhD Candidate
Bournemouth University Media School
[redacted]

The following conditions limit the release of information, as agreed between the interviewer and the interviewee:

____ None needed

JB Material may be released once corrections I specified have been made

Informed Consent For Interviews

***Digital Tides:* interfacing the technological sublime.**
A practice-based investigation into the material qualities of digital media processes.

Katy Connor
Bournemouth University

I, James Bradbury, agree to be interviewed for the project entitled ***Digital Tides,*** which is being produced by Katy Connor of Bournemouth University Media School.

I certify that I have been told of the confidentiality of information collected for this project and, if I so choose, the anonymity of my participation; that I have been given satisfactory answers to my inquiries concerning project procedures and other matters; and that I have been advised that I am free to withdraw my consent and to discontinue participation in the project or activity at any time without prejudice.

I agree to participate in one or more electronically recorded interviews for this project. I understand that such interviews and related materials and the results of this study may be published in an academic journal or book.

I agree that any information obtained from this research may be used in any way thought best for this study.

_____ Date 05/02/2014
Signature of Interviewee

JAMES BRADBURY, CALM Coordinator and Research Fellow
Centre for Additive Layer Manufacturing (CALM)
College of Engineering, Mathematics and Physical Sciences, University of Exeter
[redacted]

If you cannot obtain satisfactory answers to your questions or have comments or complaints about your treatment in this study, contact:

Katy Connor
Bournemouth University Media School
[redacted]

or

Professor Neal White (PhD Project Supervisor)
Bournemouth University Media School
[redacted]

Bournemouth University

Tel +44 (0) 1202 965360
media@bournemouth.ac.uk
http://research.bournemouth.ac.uk/centre/emerge/
http://colab.org.uk

Participant Consent Form for PhD Research

Katy Connor

Bournemouth University

Project:

Untitled_Force: 3D Print as Poetic Praxis

Dear James Bradbury,

I am writing in order to ask you to participate in my PhD research project, named ***Untitled_Force: 3D Print as Poetic Praxis,*** by permitting an extract of our email communication to be included in the final PhD exegesis.

The purpose of this form is to provide you with information so you can decide whether to participate in this study. Any questions you may have will be answered by myself, Katy Connor (the PhD researcher) or by Prof. Neal White (my Supervisor) whose contact details are provided below. Once you are familiar with the information on this form, have read the extract included, and have asked any questions you may have, you can decide whether or not to participate.

If you agree, please sign this form or else provide verbal or email consent if you do not wish your name to be registered on this form. Please also indicate whether or not you are willing for your contribution to be named. Your email address will NOT be included as part of the PhD submission.

Please note your participation is voluntary. You may decide to withdraw permission for your data to be used, at any time, up to 20th July 2016. In this case any notes, emails records and other data will be destroyed.

Project Description:
You have been asked to participate in an artistic research project that develops work through a practice-led process of 3D Print fabrication.

Purpose of the Study:
As a PhD candidate in Experimental Media, my artistic research investigates the materiality of digital process, through practices of making, critical analysis and reflection on production in the field of contemporary media arts. Through public exhibitions, my artistic practice introduces audiences to innovative and novel ways of understanding digital technologies. These works, together with written analyses, question how technologies frame, model and structure our perception and understanding of the natural world around us.

This particular body of research, named ***Untitled_Force: 3D Print as Poetic Praxis,*** explores the relationship between my blood and the machinic, through a series of metaphorical and material investigations. The PhD enquiry considers how the body becomes re-materialised, becoming techno-corporeal abstraction through techno-scientific processes. This is my distinct contribution to knowledge.

Throughout the written exegesis, *poetic praxis* is developed as my unique method of approach—both initiated and grounded by the nature of practice-led artistic research (praxis)—and philosophically inflected by *poesis:* processes of questioning and reflection that reanimate key aspects of current techno-scientific practice.

In the PhD exegesis (Volume 1: 40,000 words) I reflect upon a series of works fabricated through both two and three-dimensional print practices. I also provide a critical analysis of emergent material practices of 3D Print (also known as Additive Layer Manufacture). The exegesis elucidates the artworks, their materiality (as Nylon 12) and concludes by considering future scenarios of biological techno-scientific practice, in which the body itself becomes 'fabricated'.

A portfolio of practice (Volume 2) is presented as a parallel volume, which allows the reader to navigate documentation of the artistic research process. These stem from early studio-based experiments; tacit-intuitive approaches to materials and processes which foreground later, lab-based fabricated works. The portfolio includes photographs of the completed series of art works, collectively named as *Untitled_Force* (2011-2015) alongside documentation of their public exhibitions, reconfigured as sculptural installation at three different sites.

I argue throughout that *poetic praxis* as a methodology is a vital means of approach, revealing the unknown within existing instrumental research paradigms.

Use of the data

I have attached a PdF of the specific instances in which your emails are referenced in the PhD - namely Chapter 5: Fabrication in the Lab: A Pragmatics of Resolve and Chapter 6: Critical view on 3D Print and Appendix 6: interview with James Bradley and Appendix 9: email correspondence between K. Connor and CALM (2012-14).

The email extract will be quoted as shown and used therefore to form part of the written document. If you wish to receive a copy of the full dissertation, I am happy to provide you with an electronic reading copy.

Risks

There are no foreseeable risks from participating in this study.

Compensation

You will not receive any type of payment for participating in this study.

Statement of Privacy and Confidentiality

In any publication based on the findings of this study, the data presented will contain no identifying information that could associate it with you (including your name and email address) unless you specifically request to have your real name associated with your responses - see below.

Contact Information

My telephone number is: [redacted]

My email address is: [redacted]kconnor@bournemouth.ac.uk

Alternatively, you may wish to contact my Supervisor, Professor Neal White at [redacted]

Confirmation and consent

I confirm that I have freely agreed to participate in the PhD research project of **Katy Connor**, named *Untitled_Force: 3D Print as Poetic Praxis.*

I have been briefed on what this involves and I agree to the use of the findings as described above.

I give / do not give permission for the extract of the email to be used, as shown in the PdF extract:

I give / do not give permission for my name to be included in the PhD exegesis.

Participant signature: [signature]

Name: MR JAMES BRADBURY.

Date: 5TH OCTOBER 2016

I confirm that I agree to keep the undertakings in this contract.

Researcher signature: [signature]

Name: Katy Connor

Date: 5th October 2016

Please keep this form for future reference.

Bournemouth University

Tel +44 (0) 1202 965360
media@bournemouth.ac.uk
http://research.bournemouth.ac.uk/centre/emerge/
http://colab.org.uk

Participant Consent Form for PhD Research

Katy Connor

Bournemouth University

Project:

Untitled_Force: 3D Print as Poetic Praxis

Dear Prof. Genhua Pan,

I am writing in order to ask you to participate in my PhD research project, named ***Untitled_Force: 3D Print as Poetic Praxis,*** by permitting an extract of our email communication to be included in the final PhD exegesis.

The purpose of this form is to provide you with information so you can decide whether to participate in this study. Any questions you may have will be answered by myself, Katy Connor (the PhD researcher) or by Prof. Neal White (my Supervisor) whose contact details are provided below. Once you are familiar with the information on this form, have read the extract included, and have asked any questions you may have, you can decide whether or not to participate.

If you agree, please sign this form or else provide verbal or email consent if you do not wish your name to be registered on this form. Please also indicate whether or not you are willing for your contribution to be named. Your email address will NOT be included as part of the PhD submission.

Please note your participation is voluntary. You may decide to withdraw permission for your data to be used, at any time, **up to 20th July 2016**. In this case any notes, emails records and other data will be destroyed.

Project Description:
You have been asked to participate in an artistic research project that develops work through a practice-led process of 3D Print fabrication.

Purpose of the Study:
As a PhD candidate in Experimental Media, my artistic research investigates the materiality of digital process, through practices of making, critical analysis and reflection on production in the field of contemporary media arts. Through public exhibitions, my artistic practice introduces audiences to innovative and novel ways of understanding digital technologies. These works, together with written analyses, question how technologies frame, model and structure our perception and understanding of the natural world around us.

This particular body of research, named ***Untitled_Force: 3D Print as Poetic Praxis,*** explores the relationship between my blood and the machinic, through a series of metaphorical and material investigations. The PhD enquiry considers how the body becomes re-materialised, becoming techno-corporeal abstraction through techno-scientific processes. This is my distinct contribution to knowledge.

Throughout the written exegesis, *poetic praxis* is developed as my unique method of approach—both initiated and grounded by the nature of practice-led artistic research (praxis)—and philosophically inflected by *poesis:* processes of questioning and reflection that reanimate key aspects of current techno-scientific practice.

In the PhD exegesis (Volume 1: 40,000 words) I reflect upon a series of works fabricated through both two and three-dimensional print practices. I also provide a critical analysis of emergent material practices of 3D Print (also known as Additive Layer Manufacture). The exegesis elucidates the artworks, their materiality (as Nylon 12) and concludes by considering future scenarios of biological techno-scientific practice, in which the body itself becomes 'fabricated'.

A portfolio of practice (Volume 2) is presented as a parallel volume, which allows the reader to navigate documentation of the artistic research process. These stem from early studio-based experiments; tacit-intuitive approaches to materials and processes which foreground later, lab-based fabricated works. The portfolio includes photographs of the completed series of art works, collectively named as *Untitled_Force* (2011-2015) alongside documentation of their public exhibitions, reconfigured as sculptural installation at three different sites.

I argue throughout that *poetic praxis* as a methodology is a vital means of approach, revealing the unknown within existing instrumental research paradigms.

Use of the data

I have attached a PdF of the specific instances in which your email is referenced in the PhD - namely **Chapter 7: Work as Material Metaphor (**pages 105 -106) and **Appendix 13.**

The email extract will be quoted as shown and used therefore to form part of the written document. If you wish to receive a copy of the full dissertation, I am happy to provide you with an electronic reading copy.

Risks
There are no foreseeable risks from participating in this study.

Compensation
You will not receive any type of payment for participating in this study.

Statement of Privacy and Confidentiality

In any publication based on the findings of this study, the data presented will contain no identifying information that could associate it with you (including your name and email address) unless you specifically request to have your real name associated with your responses - see below.

Contact Information

My telephone number is: [redacted]

My email address is: [redacted]

Alternatively, you may wish to contact my Supervisor, Professor Neal White at [redacted]

Confirmation and consent

I confirm that I have freely agreed to participate in the PhD research project of **Katy Connor,** named ***Untitled_Force: 3D Print as Poetic Praxis.***

I have been briefed on what this involves and I agree to the use of the findings as described above.

I give permission for the extract of the email to be used, as shown in the PdF extract:

I give permission for my name to be included in the PhD exegesis.

Participant

signature:_____ _____

Name:_____Genhua Pan_____

Date:_____24-06-2016_____

I confirm that I agree to keep the undertakings in this contract.

Researcher

signature:__ _____

Name:_____Katy Connor _____

Date:_____ 24-06-2016_____

Please keep this form for future reference.

Statement of Privacy and Confidentiality

In any publication based on the findings of this study, the data presented will contain no identifying information that could associate it with you (including your name and email address) unless you specifically request to have your real name associated with your responses - see below.

Contact Information

My telephone number is: [redacted]

My email address is: [redacted]

Alternatively, you may wish to contact my Supervisor, Professor Neal White at [redacted]

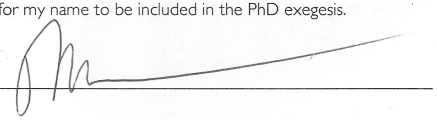
Confirmation and consent

I confirm that I have freely agreed to participate in the PhD research project of **Katy Connor,** named ***Untitled_Force: 3D Print as Poetic Praxis.***

I have been briefed on what this involves and I agree to the use of the findings as described above.

I give / ~~do not give~~ permission for the extract of the email to be used, as shown in the PdF extract:

I give / ~~do not give~~ permission for my name to be included in the PhD exegesis.

Participant signature: 

Name: David Roden

Date: 12 June 2016

I confirm that I agree to keep the undertakings in this contract.

Researcher signature: 

Name: Katy Connor

Date: 12 June 2016

Please keep this form for future reference.

Bournemouth University

Tel +44 (0) 1202 965360
media@bournemouth.ac.uk
http://research.bournemouth.ac.uk/centre/emerge/
http://colab.org.uk

Participant Consent Form for PhD Research

Katy Connor

Bournemouth University

Project:

Untitled_Force: 3D Print as Poetic Praxis

Dear Sophie Warren

I am writing in order to ask you to participate in my PhD research project, named *Untitled_Force: 3D Print as Poetic Praxis,* by permitting an extract of our email communication to be included in the final PhD exegesis.

The purpose of this form is to provide you with information so you can decide whether to participate in this study. Any questions you may have will be answered by myself, Katy Connor (the PhD researcher) or by Prof. Neal White (my Supervisor) whose contact details are provided below. Once you are familiar with the information on this form, have read the extract included, and have asked any questions you may have, you can decide whether or not to participate.

If you agree, please sign this form or else provide verbal or email consent if you do not wish your name to be registered on this form. Please also indicate whether or not you are willing for your contribution to be named. Your email address will NOT be included as part of the PhD submission.

Please note your participation is voluntary. You may decide to withdraw permission for your data to be used, at any time, up to 20th July 2016. In this case any notes, emails records and other data will be destroyed.

Project Description:
You have been asked to participate in an artistic research project that develops work through a practice-led process of 3D Print fabrication.

Purpose of the Study:
As a PhD candidate in Experimental Media, my artistic research investigates the materiality of digital process, through practices of making, critical analysis and reflection on production in the field of contemporary media arts. Through public exhibitions, my artistic practice introduces audiences to innovative and novel ways of understanding digital technologies. These works, together with written analyses, question how technologies frame, model and structure our perception and understanding of the natural world around us.

This particular body of research, named *Untitled_Force: 3D Print as Poetic Praxis,* explores the relationship between my blood and the machinic, through a series of metaphorical and material investigations. The PhD enquiry considers how the body becomes re-materialised, becoming techno-corporeal abstraction through techno-scientific processes. This is my distinct contribution to knowledge.

Throughout the written exegesis, *poetic praxis* is developed as my unique method of approach—both initiated and grounded by the nature of practice-led artistic research (praxis)—and philosophically inflected by *poesis:* processes of questioning and reflection that reanimate key aspects of current techno-scientific practice.

In the PhD exegesis (Volume 1: 40,000 words) I reflect upon a series of works fabricated through both two and three-dimensional print practices. I also provide a critical analysis of emergent material practices of 3D Print (also known as Additive Layer Manufacture). The exegesis elucidates the artworks, their materiality (as Nylon 12) and concludes by considering future scenarios of biological techno-scientific practice, in which the body itself becomes 'fabricated'.

A portfolio of practice (Volume 2) is presented as a parallel volume, which allows the reader to navigate documentation of the artistic research process. These stem from early studio-based experiments; tacit-intuitive approaches to materials and processes which foreground later, lab-based fabricated works. The portfolio includes photographs of the completed series of art works, collectively named as *Untitled_Force* (2011-2015) alongside documentation of their public exhibitions, reconfigured as sculptural installation at three different sites.

I argue throughout that *poetic praxis* as a methodology is a vital means of approach, revealing the unknown within existing instrumental research paradigms.

Use of the data

I have attached a PdF of the specific instances in which your email is referenced in the PhD - namely **Chapter 8: Exhibiting the Work** (page 122) and **Appendix 17.**

The email extract will be quoted as shown and used therefore to form part of the written document. If you wish to receive a copy of the full dissertation, I am happy to provide you with an electronic reading copy.

Risks
There are no foreseeable risks from participating in this study.

Compensation
You will not receive any type of payment for participating in this study.

Statement of Privacy and Confidentiality

In any publication based on the findings of this study, the data presented will contain no identifying information that could associate it with you (including your name and email address) unless you specifically request to have your real name associated with your responses - see below.

Contact Information

My telephone number is: [redacted]

My email address is: [redacted]

Alternatively, you may wish to contact my Supervisor, Professor Neal White at [redacted]

Confirmation and consent

I confirm that I have freely agreed to participate in the PhD research project of **Katy Connor,** named *Untitled_Force: 3D Print as Poetic Praxis.*

I have been briefed on what this involves and I agree to the use of the findings as described above.

I give / ~~do not give~~ permission for the extract of the email to be used, as shown in the PdF extract:

I give / ~~do not give~~ permission for my name to be included in the PhD exegesis.

Participant signature: Sophie Warren

Name: SOPHIE WARREN

Date: 10th June 2016

I confirm that I agree to keep the undertakings in this contract.

Researcher signature: [signature]

Name: KATY CONNOR

Date: 10th June 2016.

Please keep this form for future reference.